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Flyways and reserve networks for water birds

H. Boyd and J.-Y. Pirot (Editors)

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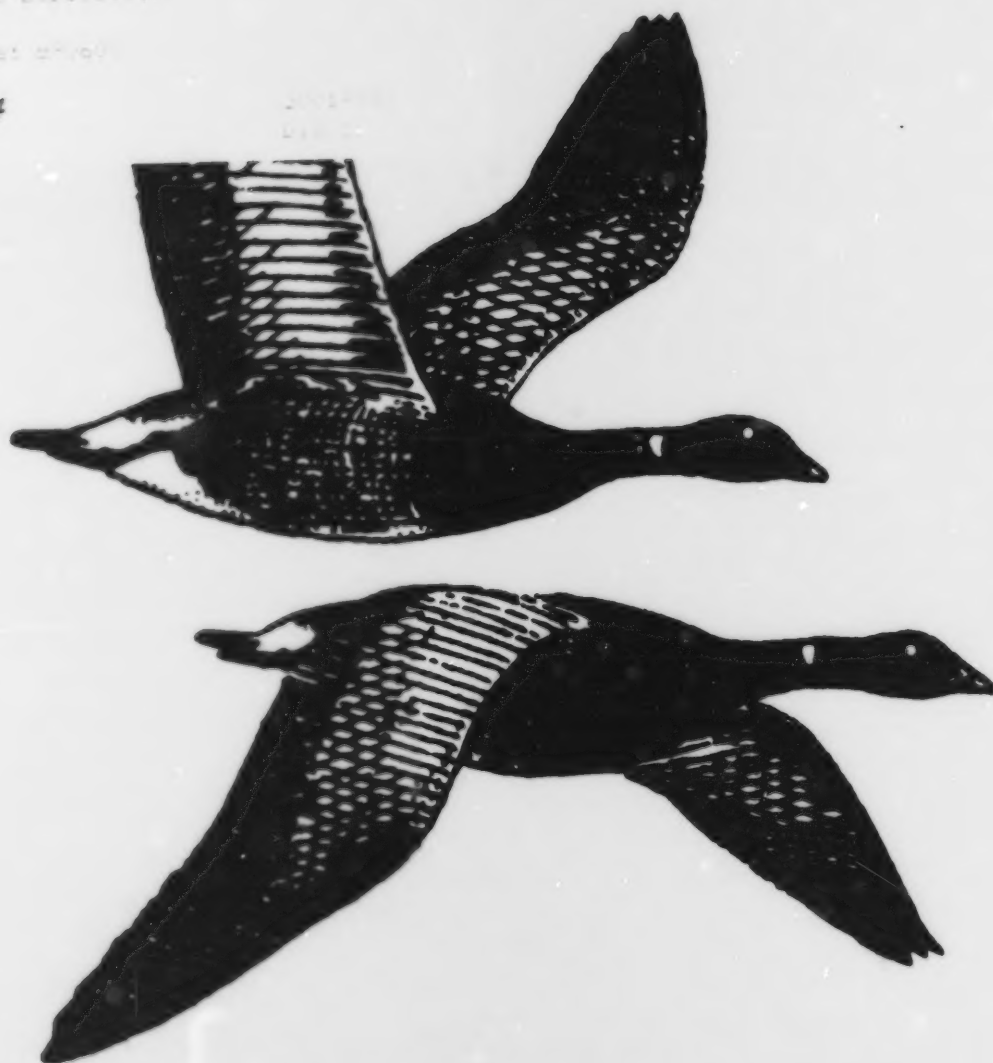
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Edited by H. Boyd and J.-Y. Pirot

Developed from papers presented at the Third Meeting of the
Conference of Contracting Parties to the Ramsar Convention,
held in Regina, Saskatchewan, Canada, 28-29 May 1987

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Introduction

This collection of reviews of the status of waterfowl, shorebirds, and other water birds in different parts of the world originated in papers presented to a workshop on flyways and reserve networks held in Regina, Saskatchewan, Canada, on 28 May 1987. The workshop was one of four held in conjunction with the Third Meeting of the Conference of the Contracting Parties to the Convention on Wetlands of International Importance, especially as Waterfowl Habitat (frequently referred to as the Ramsar Convention). Summary reports of the other three workshops are reproduced as Part 3 of this publication, because the topics they covered were closely linked with the content and purpose of the status reports. Unfortunate delays in the completion of several of the reports have made it desirable to turn the delays to advantage by adding information that became available after June 1987, so that in several cases the papers published here differ substantially from those read in Regina.

The adoption and use of the Ramsar Convention by a growing number of member states are leading to rapid developments in the thinking behind wetland conservation, as well as in the accumulation and analysis of quantitative information about the numbers and distribution of water birds and the wetland resources on which they depend. Despite our efforts at updating, the reports published here will soon be obsolete. If their publication hastens the appearance of new and improved accounts of flyways in different parts of the world, it will have fulfilled a large part of the intentions of the organizers of the Regina workshop.

Part 1

Reports



Population estimates of water birds using the East Asian/Australasian flyway

Duncan Parish

1. Abstract

The East Asian/Australasian flyway is one of the most important water bird migration pathways in the world. However, major coordinated counts of water bird species using the flyway have been conducted at relatively few sites. In this paper, I describe methods used to determine water bird population sizes in the flyway, summarize population estimates, and discuss changes in estimates and population trends where data are available. I make recommendations for regular count programs, habitat preservation, and hunting control.

2. Résumé

Le couloir de migration Asie orientale/Australasie est l'un des couloirs de migration les plus importants du monde. Des dénombrements importants des espèces d'oiseaux aquatiques utilisant ce couloir ont toutefois eu lieu de façon systématique dans un nombre relativement restreint d'emplacements. Le texte qui suit décrit les méthodes utilisées pour évaluer la taille des populations observées le long du couloir de migration. Il offre un tableau récapitulatif des estimations de ces populations et, lorsque les données le permettent, une analyse des variations notées dans ces estimations et de l'évolution démographique de ces populations. Le document contient également diverses recommandations sur les programmes de dénombrement périodiques, la préservation des habitats et les mesures restrictives touchant la chasse.

3. Introduction

The East Asian/Australasian flyway is one of the major water bird migration pathways in the world. Waterfowl using the flyway migrate principally from breeding grounds in the eastern Soviet Union, China, and Japan to Southeast Asia and Australasia (Fig. 1). The flyway is used by about 4 to 6 million waders and an unknown number of herons, ducks, geese, cranes, and other water birds. The pressure on water birds from hunting and habitat destruction is severe throughout the flyway, which contains many endangered species. Population sizes, especially of ducks, geese, and herons, have been less studied in this flyway than in most other flyways.

Until relatively recently, ornithological studies in much of the region have been related to distribution and taxonomy. Water bird migration routes were studied by a

major bird banding program in the 1960s (McClure 1974). Coordinated counts have been conducted at relatively few sites. As a result of its large size, as well as the lack of infrastructure and the variety of political and ethnic groupings in the region, major international coordinated counts of all water bird species using the flyway have not yet taken place.

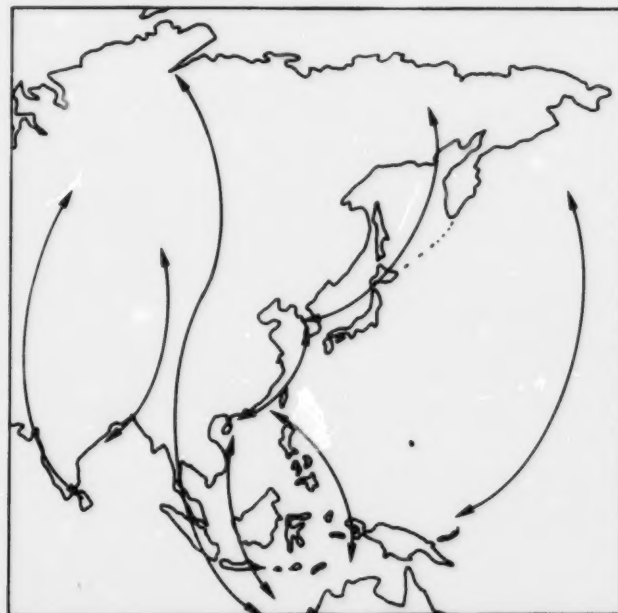
4. Study methods

Population estimates in Asia have been prepared by three main methods: coordinated counts, aerial surveys, and boat surveys.

4.1. Coordinated counts

Coordinated counts have been the principal method used in determining water bird population sizes in the flyway. Such counts have usually been conducted by large teams of amateur observers and have been timed for the breeding, peak migration, or "midwinter" (nonbreeding) periods. Because the number of trained ornithologists/

Figure 1
The East Asian/Australasian flyway



bird-watchers in the flyway is much lower in Asia than in Europe/North America, coordinated counts have been restricted to a few countries.

4.1.1. Japan

The Wild Bird Society of Japan has organized wader counts at almost all key sites since 1973. Most of the counts are made on 29 April and 15 September. The number of counting areas increased from 115 on the first count to 504 in 1985 (Wild Bird Society of Japan 1985).

In 1970, the Environmental Agency of Japan initiated midwinter waterfowl counts at 80 to 150 sites (Horiuchi 1981). Since 1982, the Wild Bird Society of Japan has organized a midwinter (15 January) count program for geese, swans, ducks, and coots. In 1982, counts were made at 1082 locations by 1135 people. It was believed that almost all the wintering swans and geese were counted, but not all the ducks (Wild Bird Society of Japan 1982).

4.1.2. Hong Kong

Midwinter waterfowl counts were initiated in Hong Kong in mid-January 1979 (Chalmers 1984). Counts were made at six to eight sites in Deep Bay over one or two days by eight to 10 observers. Counts have been continued to the present time (except for 1980).

4.1.3. Australia

National wader counts were organized by the Royal Australasian Ornithologists Union from 1981 to 1985 (Lane 1987). These counts have been continued by the Australasian Wader Study Group (Hewish 1987). Counts are held twice a year over two consecutive weekends in February and June/July. Dates are chosen to enable observers to visit coastal wetlands at high tide during the day to count birds concentrated at roosts. Many parts of Australia could not be visited during national counts, but the counts provided nearly comprehensive information on the status of shorebirds on southern and eastern coasts. In more remote parts of Australia (e.g., Western Australia, Queensland, and Northern Territories), a different area was counted each year, or birds were counted in August/September by means of aerial surveys. During the first five-year period, most potential shorebird habitats were counted comprehensively at least once.

4.1.4. Regional programs

Two major regional count programs have been initiated. In 1983, INTERWADER, the East Asia/Pacific Shorebird Study Program, started a count program for migratory waders in East Asia. Wader counts are conducted at regular intervals (two weeks to one month) in nine countries in the flyway (Thailand, Malaysia, Indonesia, Singapore, Hong Kong, Brunei, Taiwan, Japan, and China) during both northward and southward migrations. These counts are supplemented by coastal surveys that have covered a considerable proportion of the coast of Southeast Asia in the period 1983-88. Counts are now coordinated by the Asian Wetland Bureau.

In 1967/68, midwinter counts at 150 sites in West Asia were coordinated by the International Waterfowl Research Bureau (IWRB) (Atkinson-Willes 1970). Savage (1970, 1981) promoted cooperative counts in each of the Asian flyways. These counts were discontinued in the late 1970s but revitalized in 1987 (van der Ven 1987). During the counts in January 1987, more than 300 sites were surveyed — principally in Iran, Pakistan, Nepal, India, and Sri

Lanka. In 1988, the count network was extended to East Asia to link up with the ongoing count programs in Japan and Hong Kong. In January 1988, counts were made in the Philippines (10 sites), People's Republic of China (27 sites), Thailand (four sites), and South Korea (11 sites), in addition to the West Asian countries. In many countries, the counts were not comprehensive, and only a few of the wetlands were visited. It is hoped that this program will be expanded in future years.

Counts in the flyway have generally been made on foot from the land. Since 1980, however, aerial and boat surveys have become more frequent.

4.2. Aerial surveys

Aerial surveys of water birds have been conducted in China (for cranes, storks, and swans), in the Soviet Union (for cranes and breeding waders), in Southeast Asia (for waders, storks, and herons), and in Australia (for waders). Surveys have been conducted principally with fixed-wing, single-engined light aircraft (four- to six-seaters). Helicopters have been used in Malaysia, Indonesia, and northeastern China.

Between 1983 and 1988, INTERWADER and the Asian Wetland Bureau conducted aerial surveys of water birds in coastal wetlands in Thailand, Peninsular Malaysia, Sarawak, Sabah, Brunei, Java, Sumatra, and Irian Jaya. Surveys covered over 6000 km of coastline. Counts were normally made from an altitude of 80-100 m. Types and numbers of birds were noted on hand-held tape recorders. Storks, herons, and large waders were normally identified to species level. Egrets and medium-sized to small waders were normally counted by size class. These surveys were conducted principally during the periods of peak migration when numbers of birds were highest. They are thus important for identifying important sites, but not for estimating total populations of migratory species.

For count results to be used to determine population sizes, they must be made at either the breeding or nonbreeding quarters when birds are not moving between sites. Aerial surveys have been used in Australia to count numbers of wintering waders during February. Extensive aerial surveys of central China were conducted in 1980/81 to locate important areas for wintering cranes. As a result, large numbers of birds were located at Poyang Lake, the largest freshwater lake in China. In 1982-86, further aerial surveys of the lake area were conducted to count cranes and storks (Jiangxi Forestry Bureau 1987).

In May 1984, a coordinated aerial survey covering 8445 km² was conducted simultaneously in the Soviet Union, China, and Japan to assess the breeding population of Red-crowned Cranes *Grus japonensis* (Masatomi 1985). Surveys of this species were also conducted in early 1987 in their wintering quarters in Japan, China, South Korea, and North Korea (Won 1988). Aerial surveys have also been used in the Soviet Union to count the numbers of breeding Oystercatchers *Haematopus ostralegus* in Kamchatka by E.G. Lobkov.

4.3. Boat surveys

Boat surveys have been used to make counts of water birds at coastal and inland wetlands. They have been used extensively along the coasts of Southeast Asia and northeastern Australia (Parish *et al.* 1987; Garnett 1987) where mangrove forests prevent easy access/observation from inland.

5. Data analysis

In general, the data gathered from counts in the flyway are not detailed enough for complex analysis. Counts can often give only an idea of distribution, relative abundance, and minimum population size, rather than estimates of total population.

The exceptions to this rule are the comprehensive wader counts in Japan and Australia. In Australia, counts were computerized, which enabled easy compilation and printout of state and zone totals. Counts could also be mapped and key sites identified using the computer. Populations of species in each zone were estimated from the national count results over five years by taking the average of the counts for areas covered consistently from year to year, where it was clear that no major flock was missed during any count. Where there were insufficient counts to produce a reliable average, the maximum number counted was used. In Australia, it was not possible to estimate the total population size of most species because of movements between northern sites (counted by aerial surveys/expeditions in August/September) and southern sites counted in February.

In Japan, fluctuations in wader counts from 1975 to 1983 were analyzed by graphing the annual wader count results. Despite increases in coverage, the population level of some species fell, indicating real trends.

In addition to midwinter and migration counts, regular counts of certain sites have been made in Australia (Lane 1987; Alcorn 1988) and East Asia: Thailand (Ruttanadukul and Ardseungnern 1988); Malaysia (INTERWADER, unpubl. data); Brunei (Elkin and Harvey 1989); and Japan (Ishikawa and Kuwabara 1983). These counts can be graphed to show differences in timing of migration between species and years. Banding and taxonomic studies have helped to delineate the range of specific subspecies, such as the Mongolian Plover *Charadrius mongolus* (Lane 1986).

6. Population estimates

It has generally not been possible to make population estimates in the East Asian/Australasian flyway, principally because of poor coverage. Estimates have been made chiefly for extremely rare species or for those with a restricted range. The vast majority of species are often scattered among many, often inaccessible, sites in a wide variety of countries.

6.1. Rare species

Surveys and estimates of population size have frequently concentrated on rare species. Specific projects have been established to determine the populations of Double-banded Plover *Charadrius bicinctus*, Latham's Snipe *Gallinago hardwickii*, and Red-crowned Crane. Estimates of populations of some rare species are given in Table 1.

6.2. Wader population estimates

Some minimum population estimates of certain wader species can be made for the flyway, based on counts in the nonbreeding quarters. Because of a lack of coverage in Southeast Asia in the nonbreeding season, estimates can be made only for species that winter predominantly in southern Australia. Details are given in Table 2. These

Table 1
Estimates of population size for rare water bird species in the East Asian/Australasian flyway

Species	Population estimate	Reference
Crested Ibis <i>Nipponia nippon</i>	40	Luthin 1987b
Milky Stork <i>Mycteria cinerea</i>	6000	Silvius 1986
Oriental White Stork <i>Ciconia boyciana</i>	3000	Luthin 1987a
Asian Openbill Stork <i>Anasomus oscitans</i>	20 000-30 000	Luthin 1987a
Bar-headed Goose <i>Anser indicus</i>	10 000	Madge and Burn 1988
Mandarin Duck <i>Aix galericulata</i>	15 000	Madge and Burn 1988
Double-banded Plover <i>Charadrius bicinctus</i>	12 500+	Lane 1987
Asian Dowitcher <i>Limnodromus semipalmatus</i>	15 000-20 000	D. Parish and M.J. Silvius, unpubl. data
Eastern Curlew <i>Numenius madagascariensis</i>	10 000-15 000	Hayman <i>et al.</i> 1986
Latham's Snipe <i>Gallinago hardwickii</i>	27 000	Naarding 1985
Nordmann's Greenshank <i>Tringa guttifer</i>	<1000	Howes and Lambert 1987
Spoon-billed Sandpiper <i>Eurythorhynchus pygmaeus</i>	8000-10 000	Johnsgard 1981
Red-crowned Crane <i>Grus japonensis</i>	1000-1300	Masatomi 1985
Siberian Crane <i>Grus leucogeranus</i>	<2000	G.W. Archibald, pers. commun.

Table 2
Maximum counts of wader species in Australia and New Zealand, 1981-85 (from Lane 1987)

Species	Nonbreeding range	Maximum count*
Little Curlew <i>Numenius minutus</i>	N Australia	250 000
Eastern Curlew <i>Numenius madagascariensis</i>	E Australia	12 000
Great Knot <i>Calidris tenuirostris</i>	N Australia, Indonesia	350 000
Red Knot <i>Calidris canutus</i>	Australia, New Zealand	180 000 (NZ) 45 000
Curlew Sandpiper <i>Calidris ferruginea</i>	Malaysia, Indonesia, Australia	170 000
Sharp-tailed Sandpiper <i>Calidris acuminata</i>	Australia	150 000
Red-necked Stint <i>Calidris ruficollis</i>	SE Asia, Australia	270 000
Bar-tailed Godwit <i>Limosa limosa</i>	Indonesia, Australia, New Zealand	130 000 (NZ) 70 000
Other migrant species	SE Asia, Australia	350 000
Total		1 987 000

*Counts are for Australia unless indicated otherwise (NZ).

maximum counts can be taken as minimum population estimates for the flyway.

On the basis of the area of habitat, distribution, and relative abundance of species in Asia in relation to Australia, Parish (1987) estimated that the flyway population of waders is approximately 4 to 6 million birds. This figure may have to be revised upwards as more information on wintering waders in southern China and eastern Indonesia becomes available.

If the estimate is correct, the flyway wader population is considerably smaller than those found in other flyways. Thus, the number of birds found at key sites is likely to be lower in this flyway than in other flyways. This will have important implications for the identification of Ramsar sites in the region. In Europe, Africa, and North America, the numerical criterion calls for 20 000 or more waders to be using the site. In Asia and Australasia, a figure of 10 000 to 15 000 may be more appropriate. More

sites would meet the 20 000 criterion if turnover is considered, as turnover rate at many sites appears to be very high. However, in most cases, there are insufficient data to calculate total usage accurately.

6.3. Duck and goose population estimates

There have not yet been sufficient surveys of numbers of breeding and wintering ducks and geese in Asia to allow estimation of population sizes. Accurate counts have been restricted mainly to Japan, Hong Kong, and parts of the Soviet Union. Table 3 gives the current coverage of midwinter counts.

Other than in Japan, the coverage is certainly low. At Poyang Lake in China alone, an estimated 500 000 ducks and geese are known to occur (J.R. Howes, D.M. Melville, and D. Parish, unpubl. data). This is more than the number recorded in 1987/88 in all the midwinter counts outside Japan. In future it is hoped that the midwinter count program in East Asian countries will be extended to cover more areas. Until that time, no realistic population figures can be generated.

There have been some studies by Soviet scientists on the breeding grounds. Kistchinski (1981) studied breeding populations of waterfowl in Northeast Asia. Most of the information he presented is on density of breeding ducks, which is not extrapolated to population sizes. Densities ranged between 40 and 160 birds per 1000 ha. These are similar to densities found in central (Braude *et al.* 1981) and western (Mineev 1981) Siberia. Minimum estimates of the breeding populations of five species of waterfowl were given (Kistchinski 1981) (Table 4).

Densities of breeding waterfowl on the Kamchatka Peninsula were lower (20 to 60 per 1000 ha) (Gerassimov and Lobkov 1981). Because of the large size of the wetlands, the total breeding population of the peninsula may well exceed 100 000.

These limited data for a few species indicate a minimum breeding population of 1.4 million birds in Northeast Asia. The total population of all waterfowl species in East Asia is likely to be five to 10 times that.

Statistics on waterfowl hunting give some indication of duck population size. The average number of ducks and geese shot each year between 1960 and 1967 by 2.5 million hunters in the Soviet Union was about 29.5 million (Priklonsky 1970). In eastern Siberia and the Far East, 3.42 million birds were taken annually by 255 000 hunters. This study was repeated from 1970 to 1975 (Priklonsky and Sapetina 1981). Although the overall number of birds caught in the Soviet Union fell to 23 million, the kill increased by 5% in eastern Siberia, to nearly 3.6 million. According to Priklonsky (1970), the principal species caught in the eastern Siberian region were Pintail *Anas acuta*, Falcated Teal *A. falcata*, Baikal Teal *A. formosa*, and Mallard *A. platyrhynchos*. There is also extensive duck hunting in Japan (Ichida, pers. commun.) and in China (e.g., Wang 1988). Thus, the annual flyway bag probably exceeds 5 million.

As the kill by hunters is believed to have remained reasonably constant in the period 1960-75, one can assume that the numbers of ducks hunted are less than the threshold harvesting level. Patterson (1979) estimated this level to be 40% of the autumn population for dabbling ducks in North America. Because the density of hunters in eastern Siberia is relatively low, it is unlikely that 40% of the duck population is harvested; thus, the total bag may

Table 3

Totals of midwinter (January) counts of ducks and geese in certain Asian countries

Country	Year	Current midwinter count	No. of sites	Coverage
Japan	1982	1 100 000	550	High
South Korea	1988	70 000	11	Low
People's Republic of China	1988	350 000	27	Low
Hong Kong	1987	11 000	1	High
Thailand	1987	12 000	7	Low
Philippines	1988	18 000	9	Low
Total		1 561 000		

Table 4

Minimum estimates of waterfowl breeding populations in Northeast Asia (from Kistchinski 1981)

Species	Minimum estimate
White-fronted Goose <i>Anser albifrons</i>	250 000-500 000
Long-tailed Duck <i>Clangula hyemalis</i>	400 000+
Spectacled Eider <i>Somateria fischeri</i>	100 000+
Common Eider <i>Somateria mollissima</i>	400 000+
King Eider <i>Somateria spectabilis</i>	80 000

Table 5

Minimum estimates of breeding populations of major waterfowl groups in the East Asian/Australasian flyway

Group	Minimum estimates (millions)
Dabbling ducks	8-12
Diving ducks	2-3
Geese	1
Waders	4-6
Total	15-22

represent only 20-30% of the autumn duck numbers. This argument would give an autumn duck population in the flyway of 16 to 20 million. The breeding population tends to be 40-50% less than the autumn duck numbers. Thus, an estimate of the breeding population for the flyway would be 8 to 12 million dabbling ducks (Table 5). In addition, there may be several million sea and diving ducks and up to 1 million geese. In addition to the hunting in the Soviet Union, large numbers of birds are hunted in Japan and China.

6.4. Changes in estimates and population trends

Because there is relatively little information on population levels in the flyway, it is difficult to discuss actual population trends. There have been two types of changes in population estimates:

- (1) those due to revision of estimates as a result of better data; and
- (2) measurable increases or decreases in population.

Over the past decade, population estimates have been made for a variety of rare species. Luthin (1984) estimated the known world population of Milky Storks *Mycteria cinerea* to be 1000 birds. In late 1984, a survey team located 3000 Milky Storks in eastern Sumatra, and population estimates were revised to 6000 (Silvius *et al.* 1986). Until 1984, the largest group of Asian Dowitchers *Limnodromus semipalmatus* observed in Southeast Asia was 39 birds, and the world population was estimated at less than 1000 birds. During 1984, surveys coordinated by INTERWADER located 400 birds in Thailand, 339 in Hong Kong, and over 1400 in southeastern Sumatra (Parish 1985). In 1985, 400 birds were located in Sarawak (Edwards *et al.* 1985). In 1986, nearly 4000 birds were found in southeastern Sumatra (Silvius 1986). In 1988, another 1000 were located in central Java (M.J. Silvius, pers. commun.),

and 13 000 were estimated to be in southeastern Sumatra (W. Verheuyr, pers. commun.). The world population is now thought to be 15 000–20 000 (D. Parish and M.J. Silviu, unpubl. data). The Great Knot *Calidris tenuirostris* was thought to be an uncommon visitor to Australia until 340 000 were located in northern Australia between 1981 and 1985 (Lane 1987). Similar upward revisions of the populations of rare species have been made for Chinese Egret *Egretta eulophotes*, Eastern White Stork *Ciconia boyciana*, and Siberian Crane *Grus leucogeranus*. These upward revisions in population size do not indicate a recent real increase. On the contrary, most of the species mentioned above appear to have decreased in the long term. It is just that earlier estimates were too pessimistic, because inadequate surveys had been conducted.

Most actual population trends in the region have been downward. The Baikal Teal was once a common winter visitor to southwestern Japan (Austin and Kuroda 1953). Flocks of 100 000 were seen at some sites. Fifty thousand were caught in 20 days in 1947 by three men! During a count of 550 sites in Japan in January 1982, only 6000 were located. In Korea, the largest number in recent years was a flock of 20 000 observed in Chunam Reservoir in 1987 (Won 1987). The Snow Goose *Anser caerulescens* was a common visitor to Japan in the 1800s, but only one was located in the waterfowl counts of 1982. The dramatic decline is thought to be due to hunting and disturbance on the breeding ground. The remaining Asian breeding population of this species is restricted to Wrangel Island in the northeastern Soviet Union and migrates to western North America. The Wrangel Island population is declining following human settlement on the island, damage to the colony by herds of introduced reindeer, and an increasing population of arctic foxes feeding on the waste from reindeer farming (Madge and Burn 1988).

The Research Division of the Wild Bird Society of Japan (1985) analyzed trends in wader counts from 1973 to 1985. The only increases in numbers were among freshwater species, such as Little Ringed Plover *Charadrius dubius* and Common Sandpiper *Actitis hypoleucos*. These changes were probably due to increasing coverage. In contrast, the numbers of Eastern Curlew *Numenius madagascariensis* and Snowy Plover *Charadrius alexandrinus* both decreased during the period. As the surveys took place in the migration season, such changes may be due to alteration of the migration timing pattern, rather than to population fluctuation.

In eastern China, counts of ducks were made at five freshwater lakes in the 1960s and were repeated in 1985/86 (Lai 1988). The results showed that the population sizes and composition at the lakes had changed considerably: numbers of ducks had decreased by 10–40%. These decreases were attributable to a fall in diving duck numbers, due either to heavier hunting (or lower hunting threshold level) of diving ducks or to habitat changes, as the numbers of dabbling ducks had increased at all lakes.

Throughout the East Asian/Australasian flyway, the rate of habitat destruction and the level of hunting are high. In some countries (e.g., China, the Philippines), over 50% of the waterfowl habitat has been destroyed or severely degraded. Levels of hunting of waders, herons, and storks are high. In China, Japan, and central Siberia, hunting of ducks and geese is at a high level. In the breeding grounds in northern Siberia and in Australasia, the pressures from hunting and habitat destruction are relatively low, but it is

still important to protect critical habitats. Unless protection of habitat and hunting controls are enforced, it is likely that other species will follow the downward population trends of the Baikal Teal. Over 46% of the species listed in a worldwide review of waterfowl at risk (Kear and Williams 1977) occur in the flyway region.

7. Discussion

Despite the work of recent years, the East Asian/Australasian flyway is still one of the least known flyways in the world. Although the range of most species and the migration routes of some species are now known, there are few data on the overall population levels.

More detailed information will come only from a concerted effort to conduct midwinter counts throughout the region — particularly in China, Indochina, and Indonesia. Until such time, it will be difficult to monitor population trends or recommend sustainable harvest levels.

Some data on population trends can be generated from regular count programs, but care has to be taken to account for changes as a result of on-site habitat alteration or habitat loss/gain in adjacent areas.

In the absence of accurate population data, it is therefore important to continue with habitat preservation and hunting control. To date, there are only two Ramsar sites in the Asian part of the flyway (both in Japan), and more effort should be made to expand the Ramsar network. Governments of the region have shown increasing interest in wetland protection, but they frequently lack the resources to implement such measures. Assistance is therefore needed from outside agencies with funds, training, and technical advice. Without such support, it is likely that the flyway populations of many more species will dwindle.

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Population estimates of swans, geese, ducks, and Eurasian Coot *Fulica atra* in the Western Palearctic and Sahelian Africa

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1. Abstract

Population estimates for three species of swans, nine species of geese, 31 species of ducks, and Eurasian Coot *Fulica atra* wintering in the Western Palearctic and Sahelian Africa are updated. Trends in their numbers are briefly summarized and discussed. This review revises the earlier estimates reported by Scott (1980) and will be used to assess the relative importance of wetlands for each species or population according to the criteria recommended by the 1971 Ramsar Convention. Figures presented in this paper should allow the preparation of a new list of internationally important wetlands meeting the waterfowl population criteria for the region under consideration.

Most of the data used were collected through the International Waterfowl Census initiated by the International Waterfowl and Wetlands Research Bureau (IWRB), in collaboration with several research institutes from different countries. The quality of the data has increased greatly since previous estimates were made, although gaps still exist, especially in the eastern part of the region. For most species, the population estimates are higher than previous figures. This is due partly to real increases in waterfowl numbers and partly to the marked improvement in census coverage over the last 10 years. Waterfowl populations in midwinter are estimated at nearly 32 million birds for the whole region.

For the next decade, priority should be given to improvements in the coverage of the census, to more research on factors affecting waterfowl population dynamics, and to the conservation and management of key wetlands used by waterfowl populations.

2. Résumé

L'abondance des populations de trois espèces de cygnes, neuf espèces d'oies, 31 espèces de canards et de la Foulque macroule *Fulica atra* hivernant dans le Paléarctique occidental et au Sahel ont fait l'objet d'une nouvelle estimation. Les tendances démographiques de chaque espèce sont brièvement résumées et discutées. Les valeurs présentées dans cet article remplacent donc les chiffres antérieurs fournis par Scott (1980), et serviront à réévaluer l'importance relative des zones humides utilisées par chaque espèce ou population selon les critères adoptés par la Convention de Ramsar (1971). De ce fait, ces récentes estimations devraient permettre la mise à jour de la liste régionale des sites d'importance internationale pour les oiseaux d'eau.

La plupart des données ont été collectées grâce au programme de Dénombrements Internationaux d'Oiseaux d'Eau coordonné par le Bureau International de Recherches sur les Oiseaux d'Eau et les Zones Humides (BIROE), en collaboration avec d'autres organismes de recherches de plusieurs pays. La qualité des données s'est nettement améliorée depuis les premières estimations, bien que des lacunes subsistent encore dans le secteur oriental de la région. Pour la plupart des espèces, les nouvelles estimations sont plus élevées que les précédentes : ceci est lié au fait que certaines populations ont augmenté, mais aussi parce que la couverture de l'inventaire s'est notablement accrue depuis 10 ans. L'abondance des populations d'oiseaux d'eau considérées ici est aujourd'hui d'environ 32 millions d'oiseaux au milieu de l'hiver.

Diverses priorités sont envisagées pour les 10 prochaines années ; il s'agit d'abord de parfaire la couverture de l'inventaire, d'effectuer ensuite des recherches sur les facteurs susceptibles d'influencer la dynamique des populations de ces espèces, et enfin d'accroître la conservation et la gestion des zones humides les plus importantes pour les populations d'oiseaux d'eau.

3. Introduction

Migratory waterfowl cross many national boundaries and use chains of stopover sites scattered along their flyways. Although the food and spatial resources at many wetlands are available only on a cyclical basis, waterfowl are totally dependent on the integrity of a succession of wetlands where they can store the reserves needed to continue their journey southward or northward. All these sites are vulnerable to modern development, land reclamation, and pollution, and major ecological changes have already taken place on many of the most valuable European wetlands.

The conservation of waterfowl, or the wise use of these renewable populations that represent an international heritage, must be based on a sound knowledge of their numbers and distribution within each region. In the recent past, the need for increased conservation of the most threatened wetlands, or the planning of a well-adapted network of refuges in each country, was also a strong incentive for the collection of such data.

Several waterfowl species, in particular geese and ducks, are also important quarry species and therefore represent a significant economic resource. Recent data from Pinet *et al.* (1987) can be used to estimate the amount of money spent by the 1 620 000 waterfowl hunters in the

12 countries of the European Economic Community to be more than \$1.39 billion ECU (or US \$1.76 billion) annually. In the whole of Europe and the Mediterranean basin, 10 to 15 million ducks and geese are shot each year by approximately 3 200 000 hunters (Scott 1982). Consequently, it is essential that trends in these wintering populations are carefully monitored to allow their sustainable exploitation by the hunting community.

Over the last 20 years, several authors have provided estimates of the numbers of various waterfowl species occurring in the Western Palearctic and Northwest Africa, as well as in other regions. These figures have been used extensively to achieve more appropriate management of the populations. As areas where waterfowl congregate become progressively better known, estimates are also instrumental in assessing the relative importance of wetlands for each species or population. Consequently, these data have supported the development of several international conservation programs, most notably the Convention on Wetlands of International Importance especially as Waterfowl Habitat (or the Ramsar Convention, 1971).

This international treaty requires each signatory state to designate at least one of its major wetlands of international importance as a site that should be kept free of negative interference. One of the criteria for identifying wetlands of international importance is that the wetland should support at least 1% of a regional population of a waterfowl species at some part of the year. As waterfowl populations and the carrying capacity of wetlands fluctuate continuously, it would be unwise to base management priorities on old records, which may not adequately reflect the current status and distribution of the birds.

The purposes of this paper are to review the status, numbers, and distribution of three species of swans, nine species of geese, 31 species of ducks, and the Eurasian Coot *Fulica atra* wintering in the Western Palearctic and Sahelian Africa; and to summarize and discuss briefly trends in their populations. The data provided in this article should allow the updating of the previous regional inventory of internationally important wetlands (Scott 1980).

4. Material and methods

4.1. Origin of the data

Most data that are used to estimate the size of the populations were collected through the International Waterfowl Census organized by the International Waterfowl and Wetlands Research Bureau (IWRB), in collaboration with other interested organizations from several countries. The survey has been organized each January since 1967, and approximately 45 countries in Europe, West Asia, North Africa, and West Africa are now participants. For geese, additional counts are regularly made at other periods of the winter. Over 10 000 volunteer observers, coordinated on a national basis and backed by professional biologists whenever possible, have carried out the counts in the field during their spare time and at their own expense. In the early stages of the census and in difficult areas, mobile teams of visiting ornithologists were funded by IWRB, the Tour du Valat Foundation for the Study and Conservation of Nature (TDV), the Working Group for International Waterfowl Research (WIWO), the International Union for the Conservation of Nature and Natural Resources (IUCN), and ornithological sections of natural history museums in France, Denmark, and

England, to name but a few. These worked in cooperation with local ornithological societies and/or the governmental agencies responsible for wildlife resources and parks and achieved good coverage in the Mediterranean basin and West Africa.

Counts were made chiefly from the ground, but aerial surveys have often or regularly been organized over the Baltic and the North Sea, the Wadden Sea, the Shannon River valley in Ireland, the Channel and Atlantic coasts of France, the Rhône delta in France, the Guadalquivir delta in Spain, and the northern part of the Adriatic in Italy. Counts over the Senegal, Niger, Volta, and Chari/Logone river basins and Lake Chad have always been made from aircraft. Because of the difficulties in assessing the numbers of sea ducks present in the Baltic and the North Sea, a cooperative survey was started in 1987, and some preliminary results are presented here.

For several goose populations, special research groups perform counts at times when geese are most efficiently covered and assess productivity by counts of juveniles and brood sizes in the wintering flocks. For some goose populations, counts were started in the 1950s (e.g., Ebbinge 1982; Ogilvie 1982). More recently, special schemes for the monitoring of swan populations have been initiated (Beekman *et al.* 1985; Salmon and Black 1986).

4.2. Quality of the data

The quality of the data up to 1983 has been discussed by Rüger *et al.* (1986), who emphasized discrepancies between northwestern Europe and the Mediterranean basin, the latter region being less frequently and less completely surveyed. The extent of the coverage has been improved since that review. New data were received from Bulgaria (from 1977 to 1987), Finland (from 1974 to 1988), Ireland (1986), Turkey (1986, 1987, and 1988), and Yugoslavia (1987 and 1988), together with improved counts from Northwest Africa. Aerial surveys achieved complete coverage of the Sahelian wetlands of West Africa in 1984 (Roux and Jarry 1984), 1986, and 1987. However, the lack of recent data from Rumania, the Soviet sectors of the Black and Caspian seas, and the Nile basin still restricts our knowledge on the numbers of waterfowl using the eastern European/East African flyway.

4.3. Wintering regions

We use three wintering regions for Anatidae and the Eurasian Coot as defined by Atkinson-Willes (1972), Szijj (1972), and Scott (1980): the northwestern European region, the Black Sea/Mediterranean region, and the Sahel zone. For swans and geese in which discrete populations can be identified, definitions of biogeographical populations follow Atkinson-Willes (1981) for swans and, with a few modifications and additions, Timmerman *et al.* (1976) and Ogilvie (1978) for geese. Because of differences in the quality of the data, the Mediterranean region has been divided into subregions (east and west); estimates and trends for the eastern end of the Mediterranean basin are less accurate than those for the western end. When both subregions are mentioned for a single species, their populations should be considered as discrete.

4.4. Population estimates

Data analysis is based on more than 93 700 counts made at 16 200 different sites in northwestern Europe, 8050 counts made at 2310 sites in the Mediterranean region, and over 1500 counts made at more than 250 wetlands or site

units in West Africa. On average, 6000 sites were counted each winter.

Population estimates for swans, dabbling and diving ducks, and the Eurasian Coot were computed following the method used by Owen *et al.* (1986). The estimates are based on the sum of the five-year means for each site in the region in question. The regional means have been adjusted to take into account the proportion of the population that was likely to have been present on areas that were not visited (see Rüger *et al.* 1986 for details of the method). For species with very restricted ranges (e.g., Harlequin Duck *Histrionicus histrionicus*), species that are difficult to census (e.g., Whooper Swan *Cygnus cygnus*), or species for which only patchy information is available (e.g., Marbled Teal *Marmaronetta angustirostris*), and for those wintering in West Africa, estimates are derived from maximum counts made during particular winters. In a limited number of cases, estimates were personally communicated by experts having specialist knowledge of certain species.

Estimates for geese are derived from direct population counts or from the midwinter counts. When adequate data exist, estimates are based on five-year means from counts made in 1982-86 (or alternatively 1981-85). For some other goose populations, in particular those wintering in eastern Europe where complete coverage was not obtained in each winter, the most recent population estimates have been used. For a third category of populations for which consistent data are not yet available, estimates are derived from various sources and can be considered as provisional only.

Specific difficulties arise when trying to estimate numbers of sea ducks; this is because of inconsistent coverage of the census and because counts were most often made from the coasts. Coordinated aerial surveys off the coasts of Sweden, Denmark, the Federal Republic of Germany (covering both the Baltic and the Wadden Sea), and over the Dutch Wadden Sea were performed for the first time in 1987 (Laursen *et al.* 1987a; Nilsson 1987; Swennen 1987; Nehls, pers. commun.). New estimates of numbers of sea ducks wintering in Norway have recently been made available through a monitoring program of several years' duration (Nygard 1987). For other countries, estimates are based on five-year means of midwinter counts collected from 1982 to 1987. For the Channel coast west of The Netherlands and the Atlantic coast where coverage is incomplete, highest figures from 1982 to 1987 were used. For countries where no recent data are available, previous numbers given by Atkinson-Willes (1976, 1978) have been used. Additional information on population sizes and fluctuations of sea ducks was obtained from Denmark, where a countrywide aerial survey of moulting sea ducks was made in 1986 and following years (Laursen 1987; Laursen *et al.* 1987b). Details on methods, estimates, and distribution patterns will be given in a later report (K. Laursen, unpubl. data).

In all cases, population estimates refer to the mid-1980s and should be considered as conservative.

5. Results

Current estimates of the sizes of the populations of waterfowl in the various regions are given in Tables 1 and 2, which also include some introduced species whose feral populations can now be considered well established. The

detailed status and the distribution of swans, most species of dabbling and diving ducks, and the Eurasian Coot are not presented below, as a full account has been given elsewhere (Monval and Pirot 1988). Information on trends refers largely to the period from 1980 to 1986 or in some cases for the 10 years prior to 1987.

5.1. Swans

Nearly all swan populations have shown some increase in the last decade, in particular the Mute Swan *Cygnus olor* and the Whooper Swan, which have increased their breeding ranges in northern Europe and Scandinavia, respectively. However, these two species are widely dispersed on their wintering grounds in the Baltic (*C. olor*), the British Isles (*C. cygnus*), and northwestern Europe (*C. cygnus*) and are therefore particularly difficult to census accurately. The Bewick's Swan *Cygnus colymbianus bewickii* has increased its numbers considerably in Britain, where several resorts are managed specifically for this species.

5.2. Ducks and Eurasian Coot

New population estimates are 50% higher than previous figures for Shelduck *Tadorna tadorna* and diving ducks, and some estimates for dabbling ducks have increased by as much as 80%. For most species, this increase does not necessarily reflect a real increase in the size of their populations but may also be a consequence of the improvement in the coverage of the census over the last 10 years. This is particularly true for species wintering in Sahelian Africa, where estimates for Garganey *Anas querquedula* and Northern Pintail *Anas acuta* have increased four times to reach 3 million, of which over 2 300 000 were counted in 1987. However, some populations are thought to be decreasing (e.g., Eurasian Wigeon *Anas penelope* in the Mediterranean basin) or stable (e.g., Green-winged Teal *Anas crecca* and Eurasian Coot), despite the recent upward revision of their population estimates. With a few exceptions (e.g., Northern Shoveler *Anas clypeata*, which has increased at a rate of 15% per annum since 1969 in the western Mediterranean, or Tufted Duck *Aythya fuligula*), the real increases in population sizes are generally believed to be of a much smaller magnitude than the increases in population estimates.

On the basis of all records accumulated over many years, estimates for saw-bills have also been increased by 30%, despite an extremely inconsistent coverage. *Mergus* spp. are widely scattered along the coasts and hence difficult to census effectively (although fairly important concentrations of Smew *Mergus albellus* are recorded sporadically). Therefore, data available at the present time do not allow trends in saw-bill numbers in the Western Palearctic to be computed with accuracy.

5.3. Sea ducks

The only species that has significantly increased in terms of actual population size is the Common Eider *Somateria m. mollissima*, which has shown an annual increase in the Baltic of 8-12% during the last decade. The total population of Common Eider has therefore risen from 2 million in 1978-80 to 3 million at present. For other sea duck species, trends cannot yet be documented, but further aerial surveys should allow better data to be gathered in the near future.

Table 1
Population estimates and trends in swans, ducks, and the Eurasian Coot *Fulica atra* wintering in the Western Palearctic and West Africa

Species, subspecies, or population	Region where estimate is applicable	Previous estimated* numbers	New estimated numbers	Sources of new estimates ^b	Probable population trend
Mute Swan <i>Cygnus olor</i>	NW and central Europe	140 000	180 000	Monval and Pirot 1988	Increase
Bewick's Swan <i>Cygnus columbianus bewickii</i>	Black Sea/E. Mediterranean	10 000	20 000	Rüger <i>et al.</i> 1986	Increase
Whooper Swan <i>Cygnus cygnus</i>	Europe	12 000	17 000	This study ^c	Stable
	Iceland, UK, and Ireland	6 000-7 000	17 000	A. Gardarsson, unpubl. data; D.G. Salmon, unpubl. data	Increase
	NW continental Europe	15 000	25 000	Rüger <i>et al.</i> 1986	Increase
Egyptian Goose <i>Alopochen aegyptiaca</i>	Black Sea/E. Mediterranean		17 000	Rüger <i>et al.</i> 1986	?
Ruddy Shelduck <i>Tadorna ferruginea</i>	England, Netherlands (introduced)		500-600	Various sources	Stable
	W. Mediterranean	3 000	1 500	This study	?
Shelduck <i>Tadorna tadorna</i>	Black Sea/E. Mediterranean	20 000	20 000	This study	?
	NW Europe	125 000	250 000	Rüger <i>et al.</i> 1986	Increase
	W. Mediterranean	75 000	15 000	Rüger <i>et al.</i> 1986	Increase
Mandarin Duck <i>Aix galericulata</i>	Black Sea/E. Mediterranean		60 000	Rüger <i>et al.</i> 1986	?
Eurasian Wigeon <i>Anas penelope</i>	England (introduced)		1 000-1 500	Owen <i>et al.</i> 1986	Stable
	NW Europe	500 000	750 000	Rüger <i>et al.</i> 1986	Stable
Gadwall <i>Anas strepera</i>	Black Sea and Mediterranean	500 000	600 000	Rüger <i>et al.</i> 1986	Decrease
	NW Europe	5 000	12 000	Rüger <i>et al.</i> 1986	Increase
Green-winged Teal <i>Anas crecca</i>	Black Sea and Mediterranean	50 000	75 000	Monval and Pirot 1988	Stable
	NW Europe	200 000	400 000	Monval and Pirot 1988	Stable
Mallard <i>Anas platyrhynchos</i>	Black Sea and Mediterranean	750 000	1 000 000	Monval and Pirot 1988	Stable
	NW Europe	3 000 000	5 000 000	Monval and Pirot 1988	Stable
Northern Pintail <i>Anas acuta</i>	Black Sea and Mediterranean	2 000 000	4 000 000	Monval and Pirot 1988	Decrease
	NW Europe	70 000	70 000	Monval and Pirot 1988	Stable
	Black Sea and Mediterranean	250 000	300 000	Monval and Pirot 1988	Stable
Garganey <i>Anas querquedula</i>	W. Africa	250 000	1 000 000	This study	?
Northern Shoveler <i>Anas clypeata</i>	W. Africa	500 000	2 000 000	This study	?
	NW Europe	20 000	40 000	Monval and Pirot 1988	Stable
	Black Sea and Mediterranean	195 000	375 000	Monval and Pirot 1988	Increase
	W. Africa		10 000	Rüger <i>et al.</i> 1986	?
Marbled Teal <i>Marmaronetta angustirostris</i>	W. Mediterranean	2 000	2 000	This study	Decrease
Red-crested Pochard <i>Netta rufina</i>	Black Sea/E. Mediterranean		500	This study	Decrease
	Central and SW Europe	20 000	20 000	Monval and Pirot 1988	Stable
Pochard <i>Aythya ferina</i>	Black Sea/E. Mediterranean	55 000	50 000	Rüger <i>et al.</i> 1986	Decrease
	NW Europe	250 000	350 000	Monval and Pirot 1988	Decrease
Ferruginous Duck <i>Aythya nyroca</i>	Black Sea and Mediterranean	750 000	1 250 000	Monval and Pirot 1988	Decrease
	Black Sea and Mediterranean	75 000	50 000	This study	?
Tufted Duck <i>Aythya fuligula</i>	W. Africa		10 000	This study	?
	NW Europe	500 000	750 000	Monval and Pirot 1988	Stable
Scaup <i>Aythya marila</i>	Black Sea and Mediterranean	350 000	600 000	Rüger <i>et al.</i> 1986	Increase
	NW Europe	150 000	150 000	This study	?
	Black Sea and Mediterranean	50 000	50 000	This study	?
Common Eider <i>Somateria m. mollissima</i>	W. Palearctic	2 000 000	3 000 000	This study	Increase
King Eider <i>Somateria spectabilis</i>	N. Scandinavia		100 000	Nygard 1987	?
Steller's Eider <i>Polysticta stelleri</i>	N. Scandinavia		15 000	Nygard 1987	?
Harlequin Duck <i>Histrionicus histrionicus</i>	Iceland	6 500	6 500	A. Gardarsson, pers. commun.	Stable
Long-tailed Duck <i>Clangula hyemalis</i>	NW Europe	1 000 000	2 000 000	This study	?
Common Scoter <i>Melanitta nigra</i>	W. Palearctic	1 000 000	800 000	This study	?
Velvet Scoter <i>Melanitta fusca</i>	W. Palearctic	200 000	250 000	This study	?
Barrow's Goldeneye <i>Bucephala islandica</i>	Iceland	2 500	2 500	A. Gardarsson, pers. commun.	Stable
Common Goldeneye <i>Bucephala clangula</i>	NW Europe	200 000	300 000	Monval and Pirot 1988	Stable
	Black Sea and Mediterranean	20 000	20 000	Rüger <i>et al.</i> 1986	?
Smew <i>Mergus albellus</i>	NW Europe	20 000	15 000	Rüger <i>et al.</i> 1986	?
	Black Sea/E. Mediterranean	65 000	65 000	Rüger <i>et al.</i> 1986	?
Red-breasted Merganser <i>Mergus serrator</i>	NW Europe	40 000	100 000	Nygard 1987	?
	Black Sea and Mediterranean	50 000	50 000	Rüger <i>et al.</i> 1986	?
Goosander <i>Mergus merganser</i>	NW Europe	75 000	125 000	Rüger <i>et al.</i> 1986	Increase
	Black Sea/E. Mediterranean	10 000	10 000	Rüger <i>et al.</i> 1986	?
Ruddy Duck <i>Oxyura jamaicensis</i>	England (introduced)	1 500	3 000	D.G. Salmon, pers. commun.	Increase
White-headed Duck <i>Oxyura leucocephala</i>	W. Mediterranean	2 000	500	This study	Decrease
	E. Mediterranean		10 000	This study	Stable
Eurasian Coot <i>Fulica atra</i>	NW Europe	1 000 000	1 500 000	Rüger <i>et al.</i> 1986	Decrease
	Black Sea and Mediterranean	1 000 000	2 500 000	Rüger <i>et al.</i> 1986	Decrease

*Mainly from Atkinson-Willes (1976, 1978, 1981) and Scott (1980, 1982).

^bSources refer to the population estimate or to the trend, or in some cases to both.

^cFrom the IWRB Duck (and Nordic/Baltic Duck Survey) Research Group, unpublished data.

Table 2
Population estimates and trends of geese breeding and/or wintering in the Western Palearctic^a

Species/subspecies/ population	Breeding range	Winter range	Estimated population size	Trend
Bean Goose				
<i>Anser f. fabalis</i>	N Scandinavia/Siberia	NW Europe	80 000 ^b	Stable
<i>Anser f. rossicus</i>	N Russia/N Siberia	Europe	300 000 ^b	Increase?
Pink-footed Goose				
<i>Anser brachyrhynchus</i>	Iceland/E Greenland	British Isles	110 000 ^c	Increase
<i>Anser brachyrhynchus</i>	Svalbard	NW Europe	25 000 ^c	Stable
White-fronted Goose				
<i>Anser a. albifrons</i>	Siberia	NW Europe	300 000 ^c	Increase
<i>Anser a. albifrons</i>	Siberia	Central Europe	100 000 ^b	Decrease
<i>Anser a. albifrons</i>	Siberia	Black Sea/Turkey	250 000 ^b	Stable?
<i>Anser a. flavirostris</i>	W Greenland	British Isles	22 000 ^c	Increase
Lesser White-fronted Goose				
<i>Anser erythropus</i>	N Scandinavia/Siberia	Black Sea/W Asia	25 000–50 000 ^b	Decrease
Greylag Goose				
<i>Anser anser</i>	Iceland	British Isles	100 000 ^c	Increase
<i>Anser anser</i>	N Scotland	N Scotland	2 000 ^b	Stable
<i>Anser anser</i>	British Isles (feral)	British Isles	14 000 ^b	Increase
<i>Anser anser</i>	NW Europe/central Europe	Spain/Netherlands	120 000 ^b	Increase
<i>Anser anser</i>	Central Europe	N Africa	20 000 ^b	Stable
<i>Anser anser</i>	Black Sea	Black Sea	20 000 ^b	?
Canada Goose				
<i>Branta canadensis</i>	England (introduced)	England	39 000 ^b	Increase
<i>Branta canadensis</i>	Scandinavia (introduced)	Baltic Sea	50 000 ^b	Increase
Barnacle Goose				
<i>Branta leucopsis</i>	N Russia/Baltic	Netherlands	70 000 ^c	Increase
<i>Branta leucopsis</i>	E Greenland	Scotland/Ireland	32 000 ^c	Stable
<i>Branta leucopsis</i>	Svalbard	Scotland	10 000 ^c	Increase
Brent Goose				
<i>Branta b. bernicla</i>	N Siberia	W Europe	170 000 ^c	Stable
<i>Branta b. hrota</i>	N Canada/N Greenland	Ireland	20 000 ^c	Stable
<i>Branta b. hrota</i>	Svalbard	Denmark/E England	4 000 ^c	Stable
Red-breasted Goose				
<i>Branta ruficollis</i>	N Siberia	Black Sea/Caspian Sea	22 000 ^b	?

^a For sources, see Madsen (1989).

^b Based on most recent estimates.

^c Estimates based on five-year means (mostly 1982–86).

5.4. Distribution and abundance of the various species of swans and ducks

The major wintering grounds of all the above species are found mostly in the coastal wetlands of Denmark, Germany, The Netherlands, and Britain (i.e., the western Baltic, the southern and western sides of the North Sea) in northwestern Europe (Fig. 1). Another important area of concentration is represented by the coasts of the western Black Sea, Turkey, and Greece in the eastern Mediterranean. Additional wetlands of international importance are found in central Europe and the western Mediterranean. Palearctic ducks wintering in West Africa use mainly the Senegal delta and associated wetlands, but also inland water bodies as far east as Lake Chad (Fig. 2); other major resorts can probably be found even farther east in Sudan and Ethiopia, but these await further study.

Strong differences in the status of populations are also noticeable within each region. The outlook for northwestern Europe appears satisfactory, as most populations are stable or even increasing in numbers; a major decrease in population is apparent only for Common Pochard *Aythya ferina*. In the Mediterranean basin, however, several of the most common species are currently undergoing a significant decrease, although trends for up to 10 different populations cannot be documented with accuracy at present because of restricted sample sizes.

In Greece and Turkey, major sites known to hold a total of about 400 000 ducks in 1968–72 have been drained.

In the Camargue (southern France), where progressive land reclamation continues, declines in the total numbers of ducks have led to a loss of an average of 70 000 wintering ducks and Eurasian Coot since 1976. The drying up of several wetlands in Spain and Tunisia accounts for the disappearance of suitable habitats for up to 100 000 Common Pochards. In this region, several other important wetland complexes are currently being altered, and periodical droughts make these wetlands even more vulnerable to drainage.

The Ruddy Shelduck *Tadorna ferruginea*, Marbled Teal, and White-headed Duck *Oxyura leucocephala* now have very restricted ranges and limited numbers, so that their future in the Mediterranean basin is seriously threatened. Although the population estimate (75 000) given for the Ferruginous Duck *Aythya nyroca* is still quite substantial, recent surveys have failed to confirm this figure, and it may well be an overestimate. The increasing scarcity of these species ought to be better documented, and recovery plans should be drawn up as soon as possible.

The causes of recent population trends were discussed by Rüger *et al.* (1986). The development of man-made habitats, a series of mild winters during the 1970s, the increasing eutrophication of waters, behavioural and dietary shifts in some species, the increasing number of refuges, and the shortening of hunting seasons in some European countries are all likely to have had a positive effect on population numbers. Factors that may have lowered annual recruitment and the capacity to survive

over winter include extensive habitat loss through drainage, reclamation and socioeconomic development (in particular around the Mediterranean), long open seasons (especially in the southern part of the Western Palearctic), and the effects of regionally severe winters in 1979, 1982, 1985, and 1987. No comprehensive review of parameters affecting the status of duck populations at flyway level is yet available.

5.5. Geese

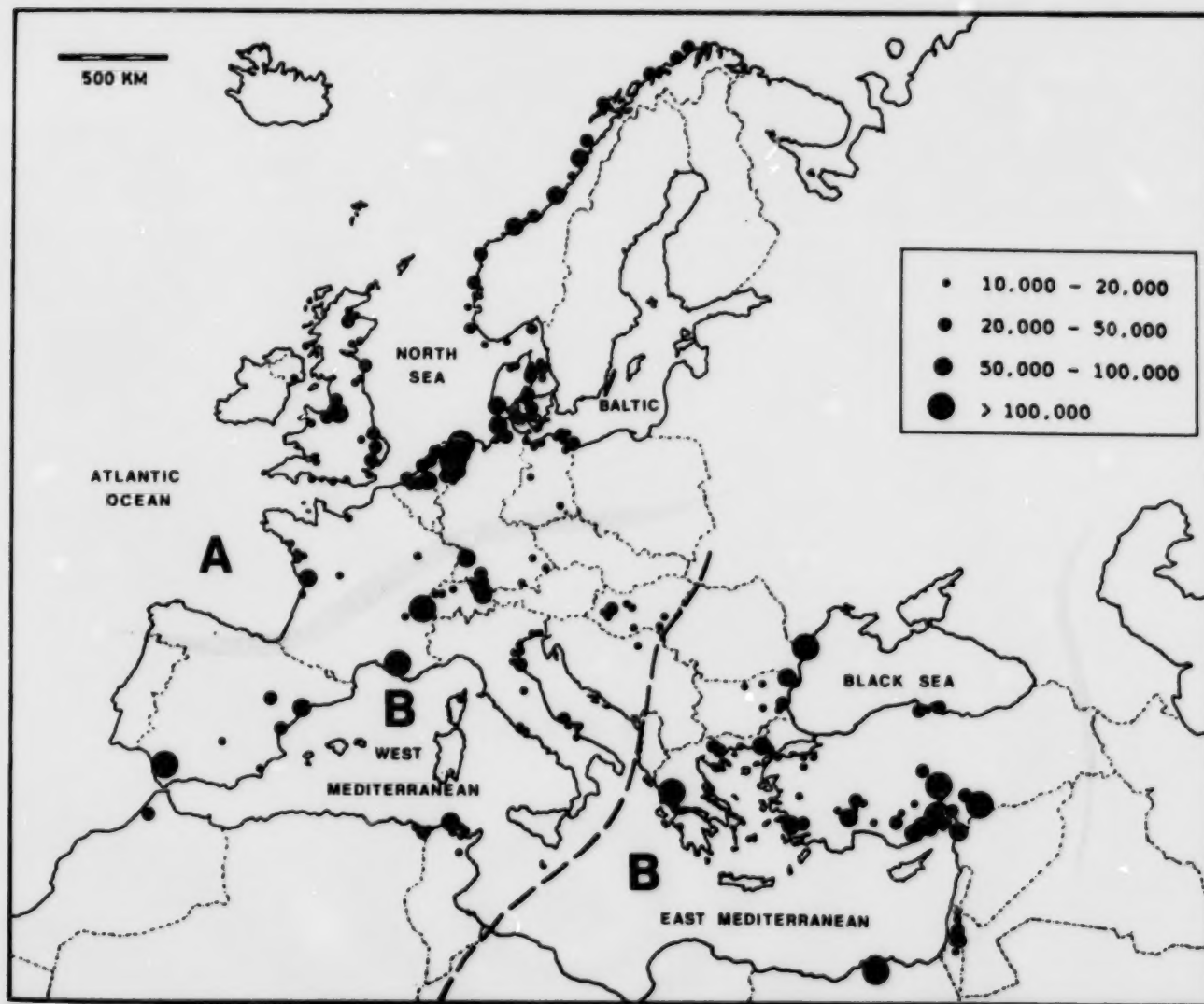
In the Western Palearctic, geese are represented by nine species that form 24 more or less strictly defined populations (Table 2), including one population of feral Greylag Goose *Anser anser* and two populations of introduced Canada Goose *Branta canadensis* (Madsen 1989). Most of these populations have increased their numbers significantly during the last decades, totalling around 2 million individuals in the mid-1980s. The most

numerous populations are represented by the continental Bean Goose *Anser fabalis rossicus* and the White-fronted Goose *A. albifrons albifrons*. The estimates for these two species are nevertheless relatively unreliable, because of lack of data from central and southeastern Europe.

Generally speaking, there are three major flyways of geese in the Western Palearctic. The British Isles are the main winter resort for six populations from breeding grounds in Iceland, Greenland, and northeastern Canada. The western part of continental Europe (including Spain) and southern England are the wintering quarters of eight populations breeding mainly in Siberia, Svalbard, and northwestern Europe. Central and southeastern Europe (including North Africa) are the wintering areas for six populations breeding in northeastern Siberia and central Europe.

The highest numbers of wintering/staging geese are found in The Netherlands, which support about 500 000

Figure 1
Main wintering grounds of swans, ducks, and the Eurasian Coot *Fulica atra* in northwestern Europe (A) and the Black Sea/Mediterranean region (B, divided into two subregions). Dots represent average numbers counted from 1982 to 1987.



geese over the annual cycle (Ebbinge *et al.* 1986). Other concentrations occur in Britain (approx. 350 000 geese over the annual cycle; Salmon *et al.* 1987), the German Democratic Republic (approx. 300 000 geese; Rutschke 1987), Poland, and Rumania.

The status of two populations is critical. The Lesser White-fronted Goose *Anser erythropus* has almost completely disappeared from its former European staging and wintering grounds, and the population breeding in Scandinavia has decreased drastically. In addition, the status of this species in the Soviet Union is unclear and should be documented in the immediate future, as should the reasons for the great decline in range and numbers.

The population of the Svalbard Light-bellied Brent Goose *Branta bernicla hrota* totals less than 4000 birds. In contrast to the Dark-bellied Brent Goose *B. b. bernicla*, the Svalbard population did not recover following the decrease in the shooting pressure on the winter range in the 1960s and 1970s. This population may now be threatened by competition from the Svalbard Barnacle Goose *B. leucopsis*, which is increasing in numbers and expanding its breeding grounds to the central nesting islands of the Light-bellied Brent Goose.

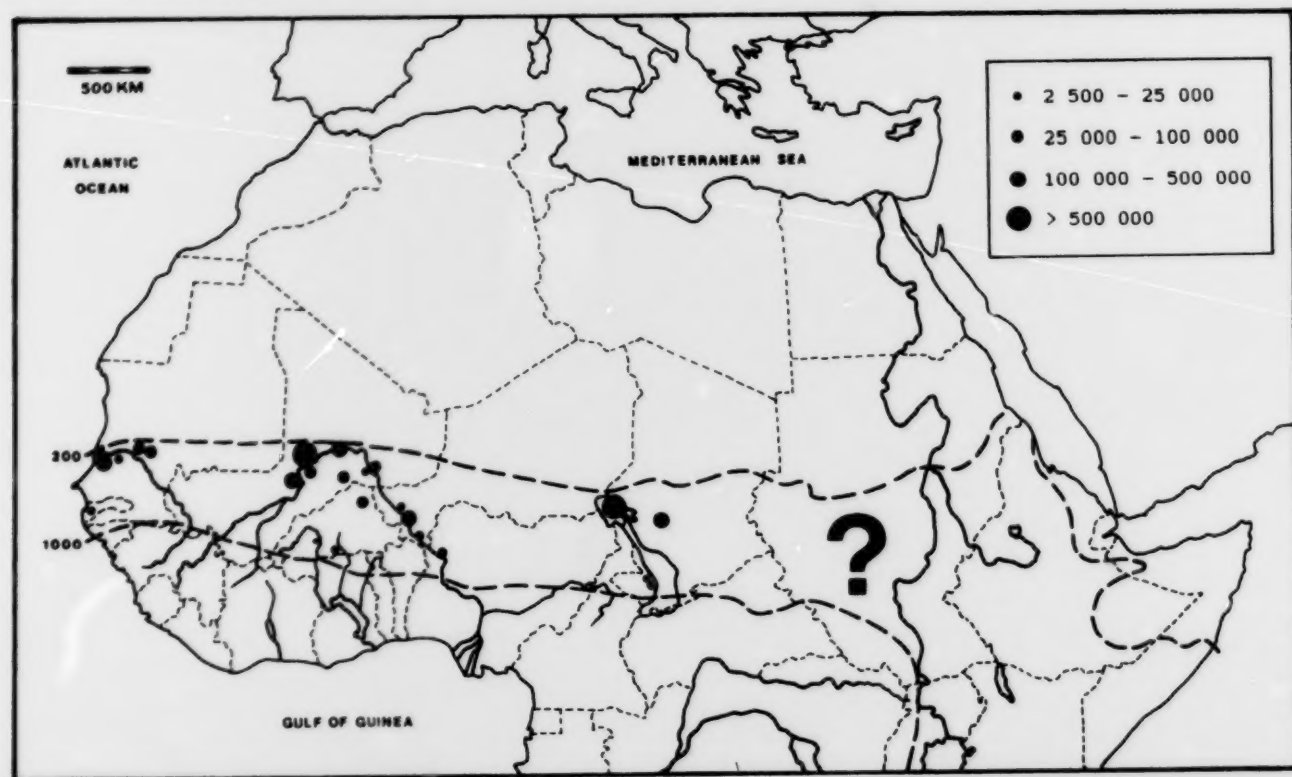
The status of the central European population of White-fronted Goose remains unclear, but it has probably decreased during recent decades. Possibly a segment of this population has changed its wintering grounds to north-western Europe, where the population size has increased.

However, the relationship between the Black Sea/eastern Mediterranean and central European populations remains unclear.

Recent trends and regulation of geese populations are reviewed in Ebbinge (1985) and Madsen (1987, 1989). For the best-known species or populations, the increase in numbers that has for most populations taken place during the last two to three decades has not been brought about by better reproduction, but by a decrease in mortality. It is believed that restriction of shooting in Europe has been the prime factor allowing better survival; therefore, shooting has seemingly been an additive, rather than compensatory, mortality factor for geese. Changes in agricultural practices on the wintering grounds may also have allowed better survival of geese by providing more secure winter forage. In most cases, however, the population increases have started abruptly over a few years, suggesting that they were caused by rapid modification in a single significant factor — e.g., shooting pressure — rather than a more gradual change — e.g., the improvement of feeding conditions in wintering and migration staging areas over a longer span of years (Ebbinge 1985). On the breeding grounds, those conditions have probably changed relatively little, although varying from year to year, except on Svalbard, where bird sanctuaries have provided protection for the Barnacle Goose. Spring shooting is still practised in the Soviet Union, but bags are unknown, and the effect on populations is therefore unclear.

Figure 2

Map of the northern part of the African continent showing the main wintering grounds of Palearctic Anatidae (adapted from Roux and Jarry 1984) between the 200- and 1000-mm rainfall zone (90% isohyet probability). Dots represent maximum numbers recorded from 1984 to 1987.



Various data suggest that the future development of these populations will depend on the carrying capacity of the environment; density-dependent mechanisms will most likely operate on the breeding grounds or the spring staging areas, and probably not so much on the wintering grounds, where new food resources on arable land and improved pastures have become available.

Several species have, during part of the winter, shifted from natural habitats to agricultural land, and the combination of changed feeding habits and increase in numbers has given rise to some damage to crops. Various means of alleviating the damage have been investigated locally (Rüger 1985), but no long-term sustainable solution has yet been agreed upon.

6. Discussion

Our knowledge of the midwinter size and distribution of waterfowl populations in the Western Palearctic and Sahelian Africa has improved considerably in the last 10 to 15 years, and a larger database is now available to better assess fluctuations in numbers. However, substantial gaps in coverage still exist, and data collection has to be considerably improved in some sectors of the region, notably the Baltic, central and southeastern Europe, the eastern Mediterranean basin, and East Africa. These areas play a key role in sheltering important proportions of some species populations, including several threatened species, or providing refuges when cold weather occurs in more northerly winter quarters.

Nevertheless, extension in the coverage should be planned with care; special emphasis should be placed on the collection of continuous sets of data, as the reliability of the trend analysis, as well as the practicability of associated statistics, depends greatly on regular counts carried out at individual sites over many successive years. Although all observations received from poorly known parts of the region are highly valuable, the improvement of the sampling procedures clearly constitutes the main priority of the survey in future years.

Waterfowl populations can now be reestimated at nearly 32 million for the whole region, a notably higher estimate than that of 16 million based on figures from 1976 to 1982. Northwestern Europe supports 17.5 million waterfowl, the Mediterranean basin 11.4 million, and Sahelian Africa 3 million (of Palearctic-breeding Anatidae). As these estimates are based on midwinter counts made after most birds harvested by hunters have been removed from the environment, they are more likely to give an indication of the potential size of prebreeding stocks than of the size of postbreeding populations and their harvestable surplus. The autumn flight of waterfowl probably amounts to 42 to 47 million birds, a figure that is derived from midwinter estimates to which estimated bags are added. However, it seems of little value to produce such a figure *a posteriori*, using probable rather than exact bag statistics. The main value of a fall flight forecast (at present made only in North America) is as a predictive tool, allowing assessment of the size of the harvest that may safely be taken in the following winter.

The main features of waterfowl management practices in Europe have been described by Scott (1982), who concluded that more information should be gathered on population numbers, production, survival estimates, and hunting mortality if effective management of popula-

tions is to take place in the region. Unfortunately, as far as ducks and swans are concerned, only modest progress has been achieved in this field over the last 10 years. For many of the goose populations, we have an increased knowledge stemming from population and age counts and intensive ringing schemes (e.g., Owen 1984). However, for most of the eastern European populations of geese, we still lack consistent data on numbers and other population parameters. A few new bag statistics have been collected since the time of Scott's (1982) study, such as those for Britain (Harradine 1985) and France (Office national de la chasse 1986). Only Denmark has integrated the collection of these data into a regular scheme, and no information about bags has ever been obtained for such countries as Egypt, Greece, Italy, and Turkey, where waterfowl hunting is an active pursuit undergoing some development. Data from production surveys of ducks on the northern breeding grounds are scarce (Haapanen and Nilsson 1979; Krivenko 1984), and it is most unlikely that these could be gathered more frequently in the future. Constant efforts during the last three to five years to encourage wing surveys (which allow an annual index of production to be calculated) have resulted in six European countries now running these studies on a regular basis. It is hoped that more countries will join this international program in the near future.

Considering the increase in the recent population estimates, it can be said only that harvesting rates for ducks appear somewhat lower than previously anticipated; however, it remains difficult to determine whether the harvest of most species is approaching the threshold level (as identified by Patterson 1979) above which hunting mortality is additive to natural mortality, as it was for geese in the recent past. This will be possible only when more data on production, population size, hunting mortality, and nonhunting mortality are available on a flyway basis.

In North America, data from breeding and harvest surveys are considered a vital prerequisite to an improved management of stocks (Boyd 1983), but this type of monitoring is clearly still beyond the reach of European waterfowl managers. Today, only a few goose populations stand a reasonable chance of being managed according to our knowledge of their population dynamics and winter requirements, provided that shooting practices and legislation remain sufficiently adaptable to allow adjustments to be made when necessary. In consequence, priority needs for the next decade can be summarized as follows:

- (1) In the absence of any other continent-wide program, the International Waterfowl Census is an important early-warning system allowing the detection of changes in populations that are potentially at risk. It ought to be extended to countries where the program is not currently active and improved in many others. Above all, its capacity to provide regular and more reliable information should be strengthened to improve the ability for remedial measures to be taken when declines are apparent. It should also be developed on a wider scale to include counts in spring and during the moulting season, about which very little is known.

- (2) Specific research on factors that affect winter survival in many species is needed. As hunting has been found responsible for the earlier limitation of several goose populations in Europe, reliable hunting kill statistics, supplemented with data on other causes of death, such as crippling loss, cold weather, lead poisoning, and predation,

would be helpful when trying to document trends in numbers. Means of avoiding excessive kills or unnecessary human causes of waterfowl mortality should be found and implemented; practices that have already been integrated in the management of wintering stocks in several European countries should also be promoted in those countries where waterfowl management is less advanced.

(3) Factors that affect habitat capacity and resource exploitation by waterfowl, notably the effects of human activities on the use of habitats by birds, have been little studied. These studies ought to be organized for key areas along the migration routes, in order to provide a better basis for the conservation of species and sites. Results in this field would also enable specific remedial actions to be identified and taken in case of environmental perturbations or serious population declines.

(4) Future conservation strategies should also put increased emphasis on the preservation and more intensive management of wetlands at important migrating and wintering sites, especially in the Mediterranean basin where most sites holding more than 50 000 waterfowl are still unprotected. In that region, the restoration of wetlands affected by drought or previous unsuccessful development and the creation of new wetlands as a way to minimize losses have received rather limited attention to date. Habitat manipulation, in particular of wetlands in semiarid climate, should be aimed at providing waterfowl with optimal amounts of food resources in order to increase the winter survival of at least some segments of the population.

7. Acknowledgements

Thousands of dedicated people have given freely of their time in collecting the data on which the results are based, and we appreciate their contribution to this paper. National organizers, species coordinators, and team leaders of expeditions are especially thanked for their cooperation and efforts. The World Wide Fund for Nature (WWF) is also thanked for having provided continuing finance for the work of IWRB. J.-Y. Monval worked for the International Waterfowl Census on secondment from the Migratory Bird Commission of the International Council for Game and Wildlife Conservation (CIC). The European Community (DG XI) helped in the collection and analysis of the data by a grant (ACE 6611/84/07-5) to the IWRB Duck Research Group. V. Taylor prepared the figures. A.D. Fox, T. Jones, and G.V.T. Matthews are thanked for their critical reviews of the manuscript.

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Numbers, midwinter distribution, and migration of wader populations using the East Atlantic flyway

Cor J. Smit and Theunis Piersma

1. Abstract

In this review, the available information on the sizes of wader populations wintering along the East Atlantic coast is summarized. The most important wintering sites for individual species are mapped, and attempts are made to distinguish biogeographical populations. Data are compared with those published by Prater (1976), illustrating the increase in knowledge over the past decade on wader populations in western Europe and West Africa.

2. Résumé

La présente étude réunit de façon succincte les données dont nous disposons sur la taille des populations de limicoles hivernant le long du secteur oriental de l'Atlantique. Le lecteur y trouvera des cartes des principales aires d'hivernage utilisées par chacune des espèces. On tente également de classifier les populations d'après les zones biogéographiques. Une analyse comparative des données colligées et de celles fournies par Prater (1976) permet de constater les progrès accomplis depuis dix ans dans notre connaissance des populations de limicoles de l'Europe de l'Ouest et de l'Afrique occidentale.

3. Introduction

The first attempt to estimate the size of wader populations wintering along the coasts of Europe and West Africa dates from the mid-1970s (Prater 1976). Since then, several expeditions and specific research projects, most of them coordinated or organized by the Wader Study Group (WSG), the British Trust for Ornithology (BTO), and the Werkgroep Internationaal Wad- en Watervogelonderzoek (WIWO foundation), have yielded many new data on numbers of wintering waders, migration routes, and timing of migration (Fig. 1). At the same time, more information on biometrics has become available, which has helped greatly in providing additional information on the location of the breeding areas of the birds concerned (Prater *et al.* 1977; Engelmoer 1984). New information has also become available through further analysis of ringing recoveries (Krägenow 1980; Roos 1984; Ilychev 1985). As well, the annual midwinter counts in northwestern Europe have been continued. As a result of these efforts in the past 10 years, a picture has gradually developed of wader populations showing rather consistent site fidelity (Symonds and Langslow 1984) and migration strategies (Pienkowski and

Pienkowski 1983), leading to the distinction of a flyway along the eastern borders of the Atlantic Ocean.

A flyway, defined as "a major route for birds on migration" (Campbell and Lack 1985), encompasses the annual migration routes of populations of waders and waterfowl between the breeding and wintering quarters, including the stopover areas in between these extremes. Flyways have already been described for wader populations elsewhere in the world (Morrison and Myers 1987; Parish *et al.* 1987), and the concept appears to be applicable to waders migrating along the East Atlantic coast (Piersma

Figure 1
Areas with the most significant increase in counting coverage (indicated in black) since Prater's (1976) review



Table 1
English, scientific, French, German, and Spanish names and Euring code of wader species mentioned in the text^a

English	Scientific	French	German	Spanish	Euring code
Oystercatcher	<i>Haematopus ostralegus</i>	Huitrier pie	Austernfischer	Ostrero	04500
Black-winged Stilt	<i>Himantopus himantopus</i>	Échasse blanche	Stelzenläufer	Cigüenuela	04550
Avocet	<i>Recurvirostra avocetta</i>	Avocette	Säbelchnäbler	Avoceta	04560
Stone Curlew	<i>Burhinus oedicnemus</i>	Oedicneme criard	Triel	Alcaraván	04590
Collared Pratincole	<i>Glareola pratincola</i>	Glareole à collier	Rotflügelbrachschnalbe	Canastera	04650
Little Ringed Plover	<i>Charadrius dubius</i>	Petit gravelot	Flussregenpfeifer	Chorlitejo chico	04690
Common Ringed Plover	<i>Charadrius hiaticula</i>	Grand gravelot	Sandregenpfeifer	Chorlitejo grande	04700
Snowy Plover	<i>Charadrius alexandrinus</i>	Pluvier neigeux	Seeregenpfeifer	Chorlitejo patinegro	04770
Eurasian Dotterel	<i>Charadrius morinellus</i>	Pluvier guignard	Mornellregenpfeifer	Chorlitejo carambolo	04820
Golden Plover	<i>Pluvialis apricaria</i>	Pluvier doré	Goldregenpfeifer	Chorlitejo dorado común	04850
Black-bellied Plover	<i>Pluvialis squatarola</i>	Pluvier argenté	Kiebitzregenpfeifer	Chorlitejo gris	04860
Northern Lapwing	<i>Vanellus vanellus</i>	Vanneau huppé	Kiebitz	Avefría	04930
Knot	<i>Calidris canutus</i>	Bécasseau maubèche	Knütt	Correlimos gordo	04960
San-ierling	<i>Calidris alba</i>	Bécasseau sanderling	Sanderling	Correlimos tridáctilo	04970
Little Stint	<i>Calidris minuta</i>	Bécasseau minute	Zwergstrandläufer	Correlimos menudo	05010
Temminck's Stint	<i>Calidris temminckii</i>	Bécasseau de Temminck	Temminckstrandläufer	Correlimos de Temminck	05020
Curlew Sandpiper	<i>Calidris ferruginea</i>	Bécasseau cocorli	Sichelstrandläufer	Correlimos zarapatin	05090
Purple Sandpiper	<i>Calidris maritima</i>	Bécasseau violet	Meerstrandläufer	Correlimos oscuro	05100
Dunlin	<i>Calidris alpina</i>	Bécasseau variable	Alpenstrandläufer	Correlimos común	05120
Ruff	<i>Phalaropus pugnax</i>	Chevalier combattant	Kampfläufer	Combattente	05170
Common Snipe	<i>Gallinago gallinago</i>	Bécassine des marais	Bekassine	Agachadiza común	05190
Black-tailed Godwit	<i>Limosa limosa</i>	Barge à queue noire	Uferschnepfe	Aguja colinegra	05320
Bar-tailed Godwit	<i>Limosa lapponica</i>	Barge rousse	Fluhlschnepfe	Aguja colipinta	05340
Whimbrel	<i>Numenius phaeopus</i>	Courlis corlieu	Regenbrachvogel	Zarapito trinador	05380
Eurasian Curlew	<i>Numenius arquata</i>	Courlis cendré	Grosser Brachvogel	Zarapito real	05410
Spotted Redshank	<i>Tringa erythropus</i>	Chevalier arlequin	Dunkler Wasserläufer	Archibebe oscura	05450
Redshank	<i>Tringa totanus</i>	Chevalier gambette	Rotschenkel	Archibebe común	05460
Marsh Sandpiper	<i>Tringa stagnatilis</i>	Chevalier stagnatilis	Teichwasserläufer	Archibebe fino	05470
Common Greenshank	<i>Tringa nebularia</i>	Chevalier aboyeur	Grünschenkel	Archibebe claro	05480
Green Sandpiper	<i>Tringa ochropus</i>	Chevalier cul-blanc	Waldwasserläufer	Andarrios grande	05530
Wood Sandpiper	<i>Tringa glareola</i>	Chevalier sylvain	Bruchwasserläufer	Andarrios bastardo	05540
Common Sandpiper	<i>Actitis hypoleucos</i>	Chevalier guignette	Flussuferläufer	Andarrios chico	05560
Ruddy Turnstone	<i>Arenaria interpres</i>	Tournepiere roux	Steinwälder	Vuelvepedras	05610

^aThe species are listed in Voous's (1973, 1977) order.

et al. 1987a). A flyway should be regarded as a generalization of the movements of bird populations. Individual birds may behave very differently, and so may smaller groups within some species (see Section 5.2.). Despite these limitations, the flyway concept has proved to be the most practicable approach for describing the movements of wader populations and for estimating their size. Estimates of the total population size of species are useful tools for conservation purposes, offering the possibility of quantifying the significance of specific sites and of distinguishing between sites of major importance and those supporting smaller numbers of birds.

In this review, the available information on the sizes of wader populations wintering along the East Atlantic coast is summarized. At the same time, the most important wintering sites for individual species are mapped; as well, attempts are made to distinguish biogeographical populations, which are sometimes, but not always, recognized as morphological "races." English, scientific, French, German, and Spanish names of species mentioned in the text are given in Table 1.

In various parts of this report, data are compared with those published by Prater (1976). Population estimates have been updated since then (Prater 1981a; Scott 1982); however, because more than 10 years have passed since Prater's first attempt, a comparison with these data gives us a good impression of the increase in knowledge on wader populations in western Europe and West Africa.

4. Processing the results of the counts

4.1. Counting methodology

Numerical information in this paper is based on counts, mostly from well-qualified amateur ornithologists

who were instructed by their regional coordinators as to where and when to count. The results were collected and processed by the national organizers. Results of the countrywide surveys were compiled by the coordinator of the Wader Research Group of the International Waterfowl and Wetlands Research Bureau (IWRB). At present, wader counts are being organized in most estuaries in Europe and Northwest Africa on a regular basis (Table 2). Farther south in West Africa and in northern Europe, the frequency with which counts are carried out decreases rapidly. In some countries, the number of counts is restricted to one per year (around mid-January); in others, additional counts are organized in autumn and spring. In some countries (e.g., Britain) or regions (parts of France, Spain, Portugal, and in the international Wadden Sea area), it has been possible to organize monthly counts during most of the year.

In this paper, emphasis has been placed on counts in January when, apart from cold weather movements, relatively little migration takes place: autumn migration has ceased and spring migration has not yet started. Maximum coverage during simultaneous counts in January therefore yields the most reliable estimate of the total numbers of waders wintering over large areas. Because total coverage of all suitable sites in any particular country is rarely achieved, the reported annual totals will nearly always be below the actual number of waders present. After correspondence with the national coordinators concerned, the figures in this paper have been corrected for omissions in counting coverage. Even if, for a specific country, data were available over a longer period, only those from 1975 to 1985 were considered for analysis.

Table 2

Countries in the East Atlantic flyway where midwinter wader surveys have been carried out, and the most important references used in this review

Country	Counts from	Annual midwinter count ^a	Completeness of coverage ^b	Reference
Iceland	1973-77	-	-	Wilson 1982
Faeroes	1980-82	-	±	Sørensen and Skeldal 1983; Bloch, <i>in litt.</i>
Denmark Wadden Sea	1974-present	+	+	Meltofte 1980; Laursen <i>et al.</i> 1987
Denmark rest of country	1974-78	-	+	Meltofte 1981
FRG (Schleswig Holstein)	1965-present	+	+	Busche 1980; Prokoach, <i>in litt.</i>
FRG (Niedersachsen)	1980-present	+	±	Knief 1982; Burdorf and Heckenroth, <i>in litt.</i>
Netherlands Wadden Sea	1972-present	+	+	Zegers 1985, and <i>in litt.</i>
Netherlands delta	1975-present	+	+	Meininger <i>et al.</i> 1984, 1985
Netherlands beach	1977-present	-	+	Meininger and Becuwe 1979
Belgium beach	1972-present	+	+	Becuwe 1983
Ireland	1971-present	+	±	Hutchinson 1979; Moser and Prŷs-Jones 1988
Great Britain	1969-present	+	+	Prater 1981a; Prŷs-Jones and Kirby 1987
France	1977-present	+	+	Mahéo 1978-86
Spain	±1975-present	+	+	Alberto and Purroy 1981, 1984
Portugal	1975-present	+	+	Rufino 1978-82; Smit 1989b
Italy	±1980-?	-	±	Perco 1984; Schenk, <i>in litt.</i>
Morocco	1972-present	-	+	Kersten and Smit 1984; Thevenot, <i>in litt.</i>
Algeria	1975-present	+	+	Bellaatreche <i>et al.</i> 1982; Smit 1986
Tunisia	1977/78, 1984	-	+	van Dijk <i>et al.</i> 1986; Czajkowski, <i>in litt.</i>
Mauritania	1979/80	-	+	Trotignon <i>et al.</i> 1980; Altenburg <i>et al.</i> 1982
Sénégal	1975-present	-	±	Meininger 1988b
Gambia	±1975	-	-	Vestergaard Jensen and Kirkeby 1980
Guinea-Bissau	1982, 1987	-	±	Zwarts 1988
Dem. Rep. Guinea	1988	-	-	Altenburg and van der Kamp 1989
Sierra Leone	1981-84	-	±	Tye and Tye 1987
Liberia	1981-87	-	+	Gatter 1988
Ghana	1986	-	+	Ntiama-Baidu and Grieve 1987
Namibia	1977-present	-	+	Summers <i>et al.</i> 1987a
South Africa	1975-present	-	+	Summers <i>et al.</i> 1987a

^a + or - denotes whether annual midwinter surveys are carried out or not.

^b Completeness of countrywide surveys is expressed as - (very incomplete coverage), ± (incomplete coverage), or + (more or less complete coverage).

4.2. Counting accuracy

According to Rappoldt *et al.* (1985) and Prater and Lloyd (1987), the accuracy of wader counts is dependent on five types of potential error:

- (1) failure to count important estuaries holding large numbers of birds;
- (2) occurrence of waders in habitats other than estuaries;
- (3) stochastic errors when counting flocks;
- (4) systematic errors (over- and underestimates) when counting flocks; and
- (5) small roosts or single birds remaining unnoticed.

The first topic has been taken account of in this review, using additional information from national coordinators. The second topic is much more difficult to deal with. Considering the amount of rocky and sandy coastline not covered in many countries, we can conclude only that the recorded total number of waders along the East Atlantic coast is very likely to increase as soon as more information on those sections of coastline becomes available. This applies especially to species typically wintering on rocky coasts, such as the Oystercatcher *Haematopus ostralegus*, Common Ringed Plover *Charadrius hiaticula*, Sanderling *Calidris alba*, Purple Sandpiper *Calidris maritima*, Dunlin *Calidris alpina*, Eurasian Curlew *Numenius arquata*, Redshank *Tringa totanus*, and Ruddy Turnstone *Arenaria interpres*.

The third, fourth, and fifth topics have been studied in the Dutch Wadden Sea (Rappoldt *et al.* 1985). Stochastic errors, resulting from the normally occurring variation in results in a series of counts, appear to be independent of flock size. The stochastic error for flocks in flight is somewhat smaller than that for flocks at rest. Stochastic errors have a tendency to decrease in size when results of different observers and areas are combined. Normally this

happens automatically when results of individual observers are added up to arrive at regional or national totals. For the Dutch Wadden Sea, the total derived stochastic error was in the order of 5-10% (relative standard deviation) for common species. Systematic over- or underestimations of a single observer do not average out but are superimposed on stochastic errors. In particular, widely scattered species or those assembling in small roosts tend to be easily overlooked. Counts of uncommon species therefore tend to yield inaccurate results, generally underestimates of the real numbers present. As a whole, however, counts can be considered as reliable tools to determine wader numbers.

4.3. Derivation of the 1% criteria

Summarized information from national coordinators was used to calculate mean figures for all countries along the East Atlantic flyway. National totals were rounded off to the nearest 100. Information on individual sites was processed in the same way, except for sites in the United Kingdom, where average peak winter counts during November-March were used (cf. Prŷs-Jones and Kirby 1987). These data yield somewhat higher figures than mean data for January, because some migration between sites may occur over the given period. Data were always rounded off to the nearest 100 or 1000.

The 1% criteria were derived from the final population estimates. For all species, the 1% criterion was rounded off to the nearest 100 (population size below 100 000), 500, or 1000 (population size over 100 000). Five species (Purple Sandpiper, Whimbrel *Numenius phaeopus*, Spotted Redshank *Tringa erythropus*, Common Greenshank *Tringa nebularia*, and Common Sandpiper *Actitis hypoleucos*) yielded highly inaccurate population estimates.

5. Division of species groups and geographical areas

5.1. The flyway concept on the East Atlantic coast

The flyway concept can be adequately used to describe the movements of specific populations of a single species only, although it is also used to describe an amalgamation of migratory routes of a group of species. This limitation is illustrated in Figure 2. An example of a very simple flyway pattern is given in Figure 2A, which summarizes the migration of Oystercatchers in Europe and Africa. Birds from northern breeding quarters migrate to northwestern Europe to winter, a small part of the population going farther south to reach Mauritania and Guinea-Bissau (see Section 7.1.). Although this pattern is somewhat oversimplified, as some local populations may contain more residents than others, this picture describes the general migration of European Oystercatchers satisfactorily.

As soon as two or more populations of one species winter in different areas, the situation becomes more complicated. Figure 2B illustrates the breeding and main wintering areas of two different Knot *Calidris canutus* populations in Europe and Africa. Both the migration routes and timing of migration for these populations are quite different. Ringing recoveries have shown that a small proportion of the Siberian breeding Knots migrate to South Africa to spend the winter (see Section 7.7.). For this species, the flyway area therefore extends from the Nearctic and Siberian breeding grounds as far south as South Africa and consists of an amalgamation of the flyway routes of the two subspecies concerned.

For Black-bellied Plovers *Pluvialis squatarola* (Fig. 2C), the situation is even more complicated. There are indications, based on biometrics, that birds from as far west as northeastern Canada and as far east as central Siberia may winter along the western European and West African coasts (Engelmoer 1984), although ringing recoveries from the westernmost breeding grounds are still lacking (see Section 7.6.). Furthermore, it is not yet known whether specific breeding populations use specific wintering areas or whether mixing of populations occurs within the wintering area. For this reason, the East Atlantic flyway of Black-bellied Plovers cannot yet be specified with more detail than is indicated in Figure 2C.

Thus, the overall East Atlantic flyway (Fig. 2D) consists of a combination of the separate flyways of all wader populations that use routes along the shores of the East Atlantic. For some species (such as the Purple Sandpiper), it extends south to western Europe; for others (e.g., the Knot), it extends as far south as Cape Province in South Africa. Probably no more than some thousands, or tens of thousands, go as far south as that. It is therefore reasonable to consider the northern coast of the Gulf of Guinea as the southern border of this amalgamated East Atlantic flyway. For reasons mentioned in Section 5.2., the southern and eastern border of the overall East Atlantic flyway is taken to be the Ivory Coast. In the species descriptions (Sections 7.1.-7.21.), the borders of the East Atlantic flyway area have been defined differently from species to species. Occasionally, these flyways may extend to South Africa. For each species, the flyway population has been divided into separate (biogeographical) populations whenever it is possible to distinguish separate breeding populations linked to specific wintering areas.

5.2. The distinction between the East Atlantic and other Eurasian/African flyways

Recoveries of ringed waders have shown that the birds using wetlands along the European Atlantic coast originate from an area ranging from at least 85°W (Ellesmere Island, Canada) to 125°E (Lena River valley and delta, central Siberia) (Branson 1987), although there are recoveries of Ruffs *Philomachus pugnax* from at least 150°E (Glutz von Blotzheim *et al.* 1975). The locations of breeding areas of the species involved differ considerably, with Knot, Sanderling, and Ruddy Turnstone providing the extremes in travelling over large distances. On the other hand, at least parts of the breeding populations of Oystercatcher, Eurasian Curlew, and Redshank from northwestern Europe hardly migrate at all (Hale 1980; Speek and Speek 1984). For many species, little is known about the exact location of the breeding areas. Birds migrating to different wintering quarters in Africa do show some overlap in breeding area, but there are indications that birds migrating to East Africa originate from breeding areas farther east than birds wintering in the west. Ringing recoveries show that this certainly applies for some freshwater species, including Ruff, Wood Sandpiper *Tringa glareola*, and Common Sandpiper (Ilychev 1985).

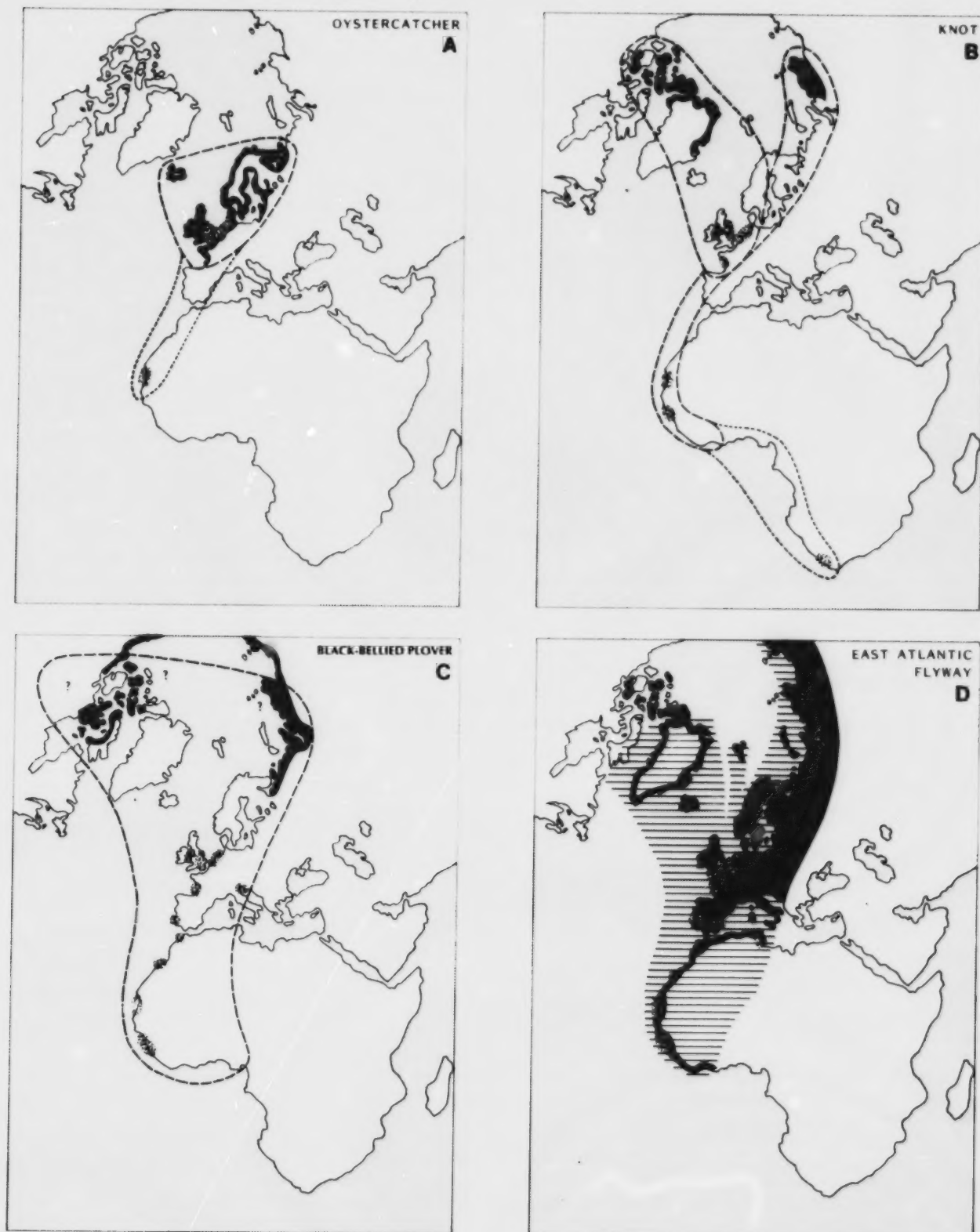
Most recoveries from ringing and colour-marking programs in northwestern Europe and West Africa point to an intensively used migration route along the East Atlantic coast (Altenburg *et al.* 1982; Pienkowski and Pienkowski 1983; Pienkowski and Evans 1984; Speek and Speek 1984; Branson 1987). Birds passing through the Baltic migrate partly through northwestern Europe and along the Atlantic coast to their wintering quarters, and partly across central Europe, either to winter in the Mediterranean basin itself or to use the latter as a stopover area during onward migration (Johnson 1974; Krägenow 1980; Gromadzka 1983; Smit 1986). Recoveries of Little Stints *Calidris minuta* show a migration route between Sénégal and the central part of the Mediterranean and the Black Sea (Moreau 1967); as well, Sanderlings and Ruddy Turnstones ringed on the Wash (east England; Branson 1987) and Curlew Sandpipers *Calidris ferruginea* and Redshanks ringed in Mauritania have been recovered in the Mediterranean (Altenburg *et al.* 1982).

A combination of all ringing recoveries yields a picture of two main migration routes from Europe to the west coast of Africa and the western part of the Gulf of Guinea (Fig. 3). In these wintering areas, birds from both migration routes apparently mix to a considerable extent, so that it is not easy to separate these routes into distinct flyways. Additional observations on the timing of migration (Tye and Tye 1987) show that adult waders in Sierra Leone arrive between August and December and leave in April and May. A comparison of phenological patterns in Sénégal and Ghana shows that waders in Ghana arrive relatively earlier (Grimes 1974). Accordingly, Tye (1987) argued that "birds wintering down the African coast as far as western Ghana may follow the coastline from north-west Africa, while birds from eastern Ghana and eastwards cross the Sahara." For this reason, birds wintering from Morocco to the Ivory Coast are considered to belong to the East Atlantic flyway.

Ringing recoveries from South Africa and East Africa are much more limited. The available information points to the distinction of two more major flyway routes

Figure 2

Flyway systems for Oystercatcher, Knot, and Black-bellied Plover along the East Atlantic coast and the generalized picture for an amalgamation of wader coastal species. Breeding areas are in black; main wintering areas are stippled. Further details can be found in Section 5.1.



between the Nearctic and Eurasian breeding grounds and the European/African wintering quarters. Waders wintering from Ghana to Angola migrate mainly through the eastern part of the Mediterranean to cross the Sahara (cf. Piersma *et al.* 1987a), whereas those wintering in the southern part of Africa follow the Rift Valley lakes or the East African coast to the Middle East and the Caspian (Summers *et al.* 1987a) (Fig. 3). In this paper, we shall refer to these three flyways as:

(1) the East Atlantic flyway, with wintering quarters ranging from Iceland and Scandinavia to West Africa, the central part of the Mediterranean, and West Africa as far east and south as the Ivory Coast;

(2) the Mediterranean flyway, with wintering areas in Egypt and the African coast between Ghana and Angola; and

(3) the East African flyway, with wintering areas in Namibia, the Republic of South Africa, the East African coast, and the Arabian Gulf.

As outlined in Section 5.1., this is the generalized picture for the whole group of waders. At a species level, the areas of these flyways may extend farther east, west, or south (cf. Piersma *et al.* 1987a). Some birds may use these routes alternately, following a route along the East Atlantic coast in autumn and following the trans-Sahara route in spring. There are indications that this is true for Curlew

Sandpipers (Wilson *et al.* 1980). These birds do not terminate in the western part of the Mediterranean, where wader numbers are lower in spring than in autumn and winter (Johnson 1974; Motis *et al.* 1981; Martinez Vilalta 1985). In the central and eastern parts of the Mediterranean, the opposite is found (Ilychev 1985; Smit 1986). These findings indicate that loop migration is likely for some species, although it is still insufficiently proven. Migrating birds in autumn may drift westward as a result of strong winds, in some years in large numbers (Stanley and Minton 1972). In spring, on their way back toward the breeding areas, these birds tend to follow a more easterly route.

5.3. The distinction between coastal and freshwater species

Prater (1976) dealt only with birds wintering along the coasts of western Europe and West Africa, south to Mauritania, including the Mediterranean and Black seas. No attempt was made to split up this wintering population into separate flyway populations or biogeographical units. As well, Prater considered only coastal waders, excluding populations wintering in noncoastal habitats.

For some species, a division into coastal and noncoastal wintering populations can be made without any problem. Black-bellied Plover, Knot, Sanderling, Dunlin, Purple Sandpiper, Bar-tailed Godwit *Limosa lapponica*, and Ruddy Turnstone are typically maritime. Common Snipe *Gallinago gallinago*, Little Ringed Plover *Charadrius dubius*, Ruff, Green Sandpiper *Tringa ochropus*, and Wood Sandpiper winter almost exclusively in freshwater habitats. Other species, such as Common Ringed Plover, Little Stint, Curlew Sandpiper, Redshank, and Common Greenshank, are found in both types of habitat. The Icelandic breeding population of the Black-tailed Godwit *Limosa limosa* behaves like a maritime species, wintering along the European Atlantic coast, whereas the western European population winters in freshwater wetlands in West and Central Africa (Altenburg and van der Kamp 1985; Beintema and Drost 1986).

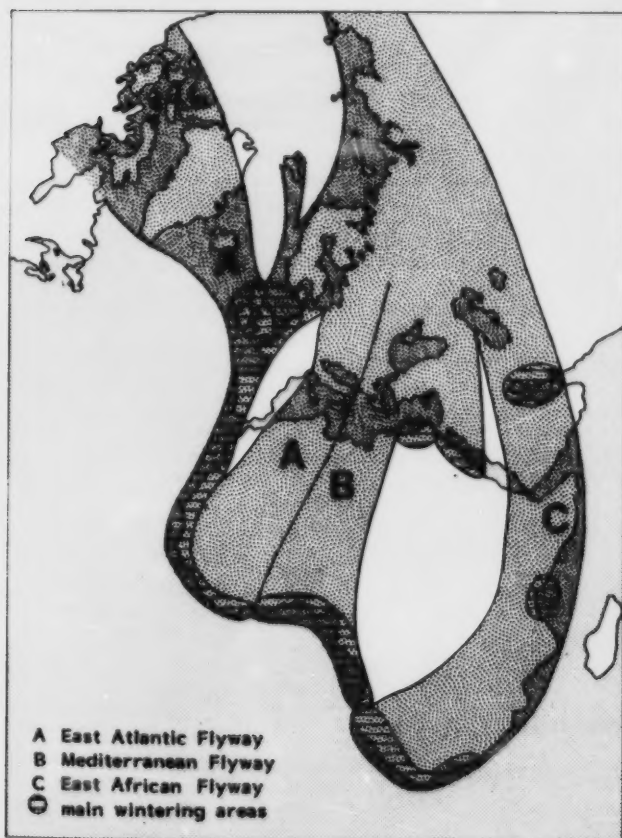
In this paper, waders wintering in freshwater habitats will once again be largely neglected, because our knowledge of their population sizes and migration routes is still much less well documented than that for most coastal waders (see Section 8.).

5.4. Species, subspecies, and biogeographical populations

Throughout this paper, we refer to species, subspecies (or morphologically distinct races), and biogeographical populations. Initially, 1% criteria were used only for describing the international importance of a site for a distinct species. For some species, such as Knot, morphologically distinct subspecies show different migratory behaviour and site use (cf. Section 7.7.). For this reason, Atkinson-Willes *et al.* (1982) introduced additional 1% criteria for subspecies, whenever there were differences in migratory pathways.

In this paper, we have extended that approach further. In some species, it may not be possible to find morphological differences between populations, although the migratory behaviour of those populations may be quite different. For reasons discussed further in Section 11.1., we have tried to distinguish such biogeographical populations among as many species as possible. For some species, for

Figure 3
Geographical extent of the flyway systems of waders breeding in the eastern Nearctic and the western and central Palearctic, and the European and African wintering areas



instance Sanderling (Section 7.8.), it has not yet been possible to do so. For others, for example Bar-tailed Godwit (Section 7.14.) and Ruddy Turnstone (Section 7.21.), we believe that enough information on differences in migratory behaviour is available to justify a distinction into separate biogeographical populations. In such cases, we developed 1% criteria for each biogeographical population. Future research will be needed to confirm the legitimacy of these differences, for instance through new DNA analysis techniques (e.g., Arctander 1988).

6. Coastal waders: the wintering areas

6.1. Wintering waders in European coastal wetlands

We distinguish flyways of distinct populations and species on the one hand and the amalgamation of these, referred to as the East Atlantic flyway, on the other. We attempt to quantify the importance of estuaries and coastal wetlands as wintering sites, as well as determine population levels for single species or distinct populations (Sections 7.1.-7.21.). Basic information for the first analysis is the mean number of waders in coastal wetlands along the European Atlantic coast, based on January counts. Data are given in Table 3, from which Golden Plover *Pluvialis apricaria*, Northern Lapwing *Vanellus vanellus*, Common Snipe, and Ruff have been excluded. These species may be present in coastal wetlands, where considerable numbers of them may roost, but generally they do not depend on coastal wetlands for food.

The total number of waders wintering along the East Atlantic European coast is somewhat in excess of 3.2 million birds. The results of surveys in most of the European estuaries have been included in this figure. However, complete coverage of all suitable areas has not been achieved in all countries, and knowledge of numbers present is still incomplete. The figure from the Faeroes is based upon only four stretches of coastline (Sørensen and Skeldal 1983; Bloch, *in litt.*). No midwinter counts from the Atlantic coast of Norway and Sweden have become available. The same holds true for most of the nonestuarine coastline in Iceland, the Republic of Ireland, France,

Spain, Portugal, and Morocco. Prater (1976) arrived at a total of 2.8 million. More detailed comparisons of old and new figures, differences in species composition, and the possible background of these differences are given in Section 11.1.

The major wintering areas (each regularly supporting over 20 000 waders) along the European Atlantic coast are listed in Table 4 and Figure 4. These 38 sites support a wintering population of 2.6 million birds, about 80% of the whole European Atlantic population.

6.2. Wintering waders in the western Mediterranean and West African coastal wetlands

Prater (1976) estimated the number of waders wintering in the Mediterranean at 120 000, excluding inland species such as Stone Curlew *Burhinus oedipnemus*, Eurasian Dotterel *Charadrius morinellus*, Golden Plover, Northern Lapwing, and Common Snipe. Smit (1986) estimated a total of 500 000 waders for the whole area, 360 000 of these wintering in the central and western part (Table 5). The relatively small number of waders wintering in a rather large area is explained mainly by the small tidal amplitude, in most places in the Mediterranean only 20-30 cm, resulting in only small amounts of intertidal feeding area. Sites supporting 20 000 or more waders in winter are the (tidal) area of the Gulf of Gabès, Tunisia, holding 267 000 birds (van Dijk *et al.* 1986), and the coast of the northern Adriatic and Po delta, holding 30 000 to 50 000 birds (Perco 1984).

Prater's (1976) data for West Africa included only those from Morocco and an incomplete survey on the Banc d'Arguin from late autumn. Much more information has become available since that time, especially from the West African coast. There are relatively frequent midwinter counts in Morocco (Thevenot, *in litt.*). Two surveys on the Banc d'Arguin (Trotignon *et al.* 1980; Altenburg *et al.* 1982) have been completed. Coastal wader numbers in Sénégal have not yet been counted simultaneously. Numbers may fluctuate strongly from year to year as a result of changing water levels caused by fluctuations in water discharge from

Table 3
Mean numbers of coastal waders wintering along the European Atlantic coast

Species	Iceland	Faeroes	Denmark excluding Wadden Sea	Denmark Wadden Sea	FRG (Schleswig Holstein) Wadden Sea	FRG (Nieder- sachsen) Wadden Sea	Nether- lands Wadden Sea	Nether- lands beach	Nether- lands delta	Belgium beach	Ireland	Great Britain estuarine coastline
Oystercatcher	3.0	-	0.1	16.0	65.0	110.0	200.0	0.3	107.0	0.6	32.5	215.0
Black-winged Stilt	-	-	-	-	-	-	-	-	-	-	-	-
Avocet	-	-	-	-	-	0.5	0.4	-	0.3	-	-	0.5
Common Ringed Plover	-	-	-	-	-	-	0.1	-	0.2	0.1	7.5	6.6
Snowy Plover	-	-	-	-	-	-	-	-	-	-	-	-
Black-bellied Plover	-	-	-	0.1	1.0	1.0	2.5	-	7.2	0.1	1.2	19.2
Knot	-	-	-	0.2	5.0	3.0	50.0	-	15.0	-	30.0	218.0
Sanderling	-	-	0.2	-	0.1	1.5	2.0	0.9	1	0.6	2.0	4.6
Little Stint	-	-	-	-	-	-	-	-	-	-	-	-
Curlew Sandpiper	-	-	-	-	-	-	-	-	-	-	-	-
Purple Sandpiper	5.0	1.0	-	-	0.1	0.1	0.1	0.2	1.5	0.3	-	0.5
Dunlin	-	-	3.2	9.0	20.0	65.0	90.0	-	91.0	1.1	115.0	409.0
Black-tailed Godwit	-	-	-	-	-	-	-	-	0.1	-	9.0	4.8
Bar-tailed Godwit	-	-	-	1.1	3.0	1.0	20.0	-	7.9	-	18.0	55.9
Whimbrel	-	-	-	-	-	-	-	-	-	-	-	-
Eurasian Curlew	0.1	-	0.1	1.1	15.0	25.0	50.0	-	11.6	0.9	100.0	48.1
Spotted Redshank	-	-	-	-	-	-	-	-	-	-	-	0.1
Redshank	0.2	-	0.9	0.7	1.5	3.0	9.0	-	3.2	0.2	14.5	54.3
Common Greenshank	-	-	-	-	-	-	-	-	-	-	0.4	0.4
Common Sandpiper	-	-	-	-	-	-	-	-	-	-	-	-
Ruddy Turnstone	2.0	1.4	-	-	0.3	0.8	2.5	0.6	2.6	0.6	5.0	9.8

Total

the large rivers. The national total presented in this paper is based on the addition of data from separate surveys (Meininger 1988b). Data for Mauritania were obtained by calculating the mean numbers on the Banc d'Arguin from Trotignon *et al.* (1980) and Altenburg *et al.* (1982), combined with the figures from the Baie d'Arguin (halfway between the Banc d'Arguin and Nouadhibou) and the Cap Blanc peninsula (=Presque Île de Cap Blanc) near Nouadhibou and results from surveys from the south-western part of the country (van Wetten 1989). Population estimates for Sierra Leone were calculated using the species composition from two estuaries and the estimate of the number of waders along the whole coastline (Tye and Tye 1987). Data from Guinea-Bissau are based on an extrapolation from low-water counts, covering 23% of the total area (Zwarts 1988). Totals from the Canary Islands are extrapolations, based on samples from sandy and rocky coastline from three islands from mid-March to mid-April 1986 (Piersma 1986a) (Fig. 5).

By far the most important wintering area on the whole western European and West African coast is the Banc d'Arguin in Mauritania, supporting over 2.0 million wintering waders (Table 6). Not yet surveyed, but possibly of great importance, is the Baia de Rio de Oro near Dakhla in the western Sahara. A preliminary survey of wetlands in the Democratic Republic of Guinea shows that the intertidal area amounts to 500 km², probably supporting about 400 000 coastal waders in winter (Altenburg and van der Kamp 1989). As the species composition in this area is still not known, the numbers wintering there have not been taken into account when calculating the population sizes of individual species. According to Tye (1987), Sierra Leone is situated on the southern edge of a strip of muddy coasts, extending south from Cap Skirring in Sénégal. From Cap St. Anne in Sierra Leone to the Liberia/Ivory Coast border, the entire coast consists of an exposed and narrow sand beach, relieved only by some rocky headlands in Liberia and some small inlets, the whole area of intertidal flats not exceeding 100 ha. Tye and Tye (1987) estimated that Sierra Leone holds 130 000 to 200 000 waders in winter. Numbers in Liberia are estimated at 35 000 (Gatter 1988). The Ivory

Table 4
Main wintering sites of waders along the European Atlantic coast, supporting over 20 000 waders

Country	Site ^a	No. present ^b
Denmark	1 Vadehavet	30 000
FRG	2 Wattenmeer Schleswig-Holstein	110 000
	3 Wattenmeer Niedersachsen	210 000
The Netherlands	4 Waddenzee	450 000
	5 Delta	250 000
Ireland	6 Shannon/Fergus	30 000
	7 Dublin Bay	30 000
	8 Dundalk Bay	44 000
United Kingdom	9 Duddon	22 000
	10 Blackwater/Colne/Dengie	30 000
	11 Orwell/Stour	30 000
	12 Medway	29 000
	13 Lindisfarne	29 000
	14 Mersey	32 000
	15 Swale	33 000
	16 Burry Inlet	35 000
	17 Firth of Forth	37 000
	18/19 Langstone/Chichester Harbour	50 000
	20 Strangford Lough	48 000
	21/24 Alt/Ribble	61 000
	22 Severn	54 000
	23 Solway	66 000
	25 Humber	83 000
	26 Dee	83 000
	27 Thames	85 000
	28 Morecambe Bay	155 000
	29 Wash	179 000
	30 Uists	21 000
	31 Strathclyde coast	40 000
France	32 Orkneys	51 000
	33 Golfe de Morbihan	27 000
	34 Baie de Mont St. Michel	55 000
	35 Charente Maritime	80 000
	36 Basin d'Arcachon	100 000
Portugal	37 Tejo	54 000
Italy	38 N Adriatic and Po delta	40 000

^aSite numbers can be retrieved in Figure 5.

^bNumbers refer to average peak numbers (United Kingdom) and mean numbers (rest).

Figure 4
Main wintering sites of waders along the European Atlantic coast, supporting more than 20 000 waders. Data are based on mean numbers in January.



Great Britain non-estuarine coastline	French Atlantic estuarine coastline	French Atlantic non-estuarine coastline	Spain Atlantic	Portugal	Atlantic coast Europe
64.5	39.0	1.0	1.5	0.4	855.9
-	-	-	0.6	0.1	0.7
-	16.0	-	4.2	12.6	34.5
16.4	5.2	0.8	3.5	2.1	42.5
-	0.2	-	3.8	1.1	5.1
2.1	16.1	0.9	3.0	6.8	61.2
4.8	19.5	-	1.0	0.8	347.3
9.2	0.7	2.3	1.2	0.2	26.6
-	0.1	-	1.0	0.4	1.5
-	-	-	0.2	-	0.2
20.0	-	3.5	0.1	-	32.4
24.0	234.0	6.0	20.0	48.2	1135.5
-	6.5	-	16.0	9.1	45.5
4.9	7.0	-	1.0	5.1	124.9
-	-	-	0.3	-	0.3
43.1	15.2	0.8	1.9	1.8	314.7
-	0.1	-	0.1	0.1	0.4
21.1	3.8	-	4.5	4.7	121.6
-	0.1	-	0.1	0.1	1.1
-	0.1	-	0.5	-	0.6
34.7	0.2	5.8	1.0	0.1	67.4

5207.9

Table 5
Numbers of coastal waders wintering in the western part of the Mediterranean and along the West African coast from Morocco to Sierra Leone^a

Species	Spain	France	Italy	Algeria	Tunisia	Western part of Mediterranean	Morocco	Mauritania	Senegal	Guinea-Bissau	Gambia	Liberia	Canary Islands	West African coast	Overall total
Oystercatcher	-	-	-	-	2.9	2.9	1.4	8.2	2.5	2.4	0.3	-	-	13.4	873.6
Black-winged Stilt	-	-	-	0.5	1.1	1.6	0.9	-	2.5	-	0.2	-	-	3.2	5.9
Avocet	0.9	0.5	2.0	1.8	9.2	14.4	2.9	2.5	12.5	0.3	0.1	-	-	7.1	67.2
Common Ringed Plover	0.1	-	0.2	-	0.4	0.7	4.3	122.2	3.0	57.4	0.2	0.8	0.1	184.1	231.2
Snowy Plover	0.5	0.1	2.3	1.0	13.5	17.2	3.6	18.5	3.0	18.6	0.1	0.1	0.4	34.9	66.6
Black-bellied Plover	0.6	0.3	1.8	-	20.5	23.2	4.0	19.3	0.8	56.7	0.1	0.3	0.8	81.3	166.4
Knot	-	-	-	-	0.1	0.1	2.5	364.3	0.8	143.8	0.2	0.1	-	500.5	857.1
Sanderling	0.1	-	0.1	0.1	0.3	0.6	2.1	21.2	7.3	10.8	0.5	0.3	2.4	43.0	71.8
Little Stint	0.6	0.2	12.5	2.3	22.9	38.5	2.0	30.6	15.0	123.0	0.5	0.2	-	158.1	211.3
Curlew Sandpiper	-	-	-	-	5.1	5.1	0.2	157.7	7.3	249.3	0.2	0.7	-	409.1	420.9
Purple Sandpiper	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32.4
Dunlin	5.2	1.4	15.5	1.9	178.0	202.0	32.0	779.2	0.8	1.8	10.0	-	0.3	813.8	2161.6
Black-tailed Godwit	2.1	-	-	0.4	2.2	4.7	18.5	3.1	12.5	-	1.0	-	-	28.5	85.3
Bar-tailed Godwit	-	-	-	-	2.1	2.1	3.0	542.2	2.5	155.6	0.3	0.1	0.7	704.6	821.4
Whimbrel	0.1	-	-	-	-	0.1	0.6	18.6	2.3	41.5	1.0	1.2	0.3	63.8	65.9
Eurasian Curlew	0.1	0.1	4.0	0.1	11.8	16.1	1.0	8.0	0.2	8.2	0.1	-	-	17.3	348.3
Spotted Redshank	-	-	1.1	0.1	1.3	2.5	0.3	0.2	0.8	0.1	0.2	-	-	1.3	4.5
Redshank	0.5	0.2	3.0	0.2	17.1	21.0	6.6	50.8	1.5	82.6	0.1	1.0	-	142.7	285.2
Common Greenshank	0.1	-	0.5	-	0.7	1.3	0.4	1.3	2.3	3.8	0.2	3.0	-	7.9	13.4
Common Sandpiper	-	-	0.7	-	-	0.7	0.3	-	-	9.1	0.2	27.5	0.1	11.8	38.5
Ruddy Turnstone	-	-	-	-	0.5	0.5	0.6	12.0	1.5	14.9	0.4	-	1.8	30.3	99.1
Total						360.0								3364.4	6927.6

^aIf sufficient data were available, mean numbers were used.

Coast has approximately 350 km of lagoon shoreline, the amount of intertidal flats being less than 500 ha (Tye 1987). Taking into account the fact that the Ghana coast supports 42 000 wintering waders (Ntiemoa-Baidu and Grieve 1987) along 200 km of coastline, we conservatively estimate the total wintering population of the Ivory Coast to be 50 000 birds. The number of waders wintering between Sierra Leone and the Ivory Coast therefore amounts to about 650 000 birds. Including these figures, the total number of waders using the East Atlantic flyway can be estimated at more than 7.5 million birds (Table 7). The relative abundance of the different species of coastal waders is indicated in Figure 6.

6.3. Wintering waders of the related flyways

Our knowledge of wader numbers and species composition of waders wintering along the African coast from Ghana to Angola, the southern limit of the wintering range of the Mediterranean flyway, is still relatively poor (Altenburg 1987). Egypt is the most important wintering site in the eastern part of the Mediterranean, supporting 100 000 waders (Meininger and Mullié 1981). Numbers of waders known to winter in Greece are 21 000 and in Turkey 14 000, although in Turkey the actual figure may be considerably higher. In Israel, only 3500 waders winter, excluding the figures for several *Vanellus* species (Smit 1986). In Ghana, 42 000 birds winter (Ntiemoa-Baidu and Grieve 1987). Assuming a wader density of five birds per hectare on intertidal flats and two birds per kilometre on the open coast (Tye 1987), we arrive at a figure of 300 000 birds between Ghana and Angola. This is a minimum figure, because wader densities in several places are underestimated. This implies that the total number of coastal waders using the Mediterranean flyway is approximately 450 000 birds, considerably less than in West Africa.

A summary of numbers of waders wintering in South and East Africa and their movements is given in Summers *et al.* (1987a). Wader numbers in Namibia and

Figure 5
Main wintering sites of waders along the West African Atlantic coast and the western part of the Mediterranean, supporting or expected to support more than 20 000 waders

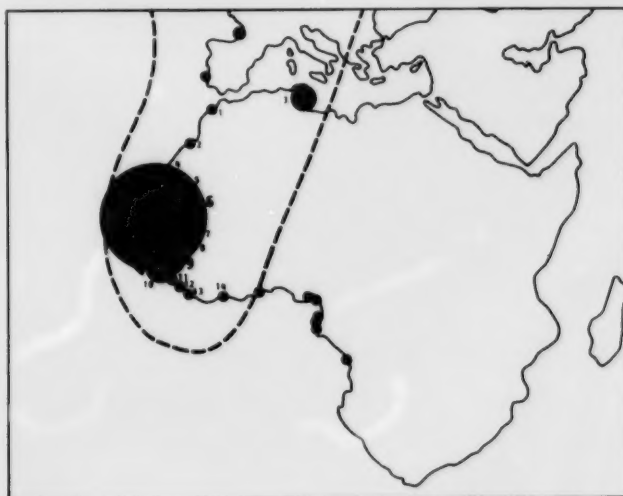


Table 6
Main wintering sites of waders along the African Atlantic coast, supporting over 20 000 waders

Country	Site ^a	No. present ^b
Morocco	1 Sebka Tazra	24 000
	2 Merja Zerga	45 000
Tunisia	3 Golfe de Gabès	267 000
Western Sahara	4 Baia de Rio de Oro	?
Mauritania	5 Baie d'Arguin	90 000
	6 Banc d'Arguin	2 038 000
Sénégal	7 Sénégal delta	24 000
	8 Saloum delta	26 000
Guinea-Bissau	9 Arquipélago dos Bijagos	980 000
Dem. Rep. Guinea	10 Whole coastline	400 000
Sierra Leone	11 Sierra Leone River	50 000
	12 Yawri bay	50 000
	13 Sherbo River	40 000
Liberia	14 Whole country	35 000

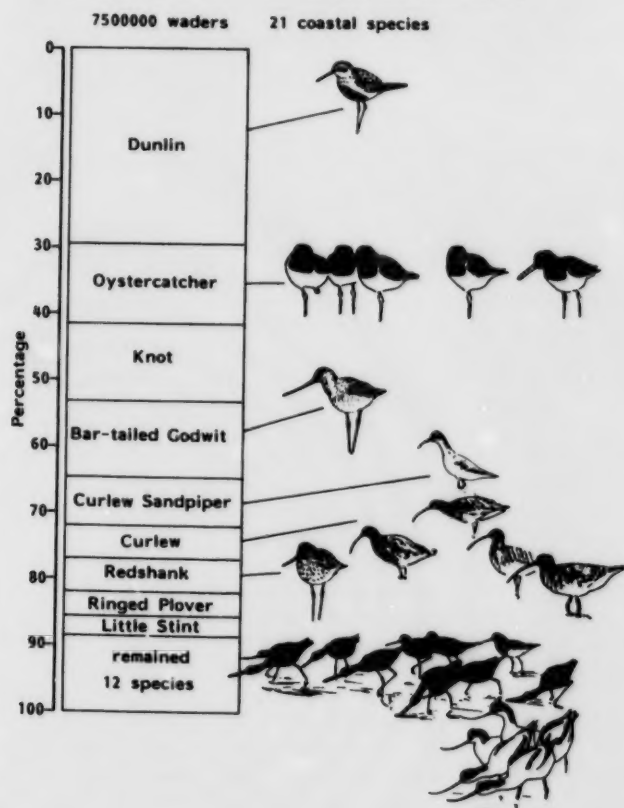
^aSite numbers can be retrieved in Figure 5.

^bNumbers refer to mean numbers or single counts.

Table 7
Numbers of coastal waders wintering along the Atlantic coasts of Europe and Africa and the western part of the Mediterranean

Area	No. of wintering waders	Source of the information
Atlantic coast of Europe	3 208 000	Mean results of January counts
Western part of the Mediterranean	360 000	Mean results of January counts and single counts
West Africa (Morocco to Guinea-Bissau)	3 329 000	January means (Morocco) Single counts (Mauritania, Sénégal, Senegambia) Extrapolations (Guinea-Bissau, Canary Islands)
Sierra Leone - Ivory Coast	650 000	Extrapolations (Sierra Leone, Liberia) Estimate based on counts in Ghana (Ivory Coast) Estimates based on maritime charts (rest)
Total	7 547 000	

Figure 6
Species composition of coastal waders using the East Atlantic flyway



South Africa amount to 357 000, those in coastal Kenya to 70 000. Estimates of wintering numbers are available from the Red Sea coast in Ethiopia (60 000) and in Sudan (70 000). Data from the Djibouti coast (8000 birds on a few kilometres of coastline; Ash 1985) indicate that we still have poor knowledge of overall coastal wader numbers in this region. Large numbers of waders wintering inland are found in Sudan (very rough estimates of 3 million birds, mainly Little Stint, Ruff, and Green Sandpiper) and around Lake Chad (in the order of 1 million). Smaller concentrations are found in Zambia, Ethiopia, Uganda, and Burundi. Price *et al.* (1986) estimated that 1 to 2 million waders winter around the Arabian Gulf. This means that the total number of coastal waders using the East African/Middle East flyway at present may be estimated at roughly 2 million birds, with another 4 million or more wintering inland. This is probably an underestimate, because of incomplete coverage of the East African coast.

7. Coastal waders: species accounts

7.1. Oystercatcher *Haematopus ostralegus*

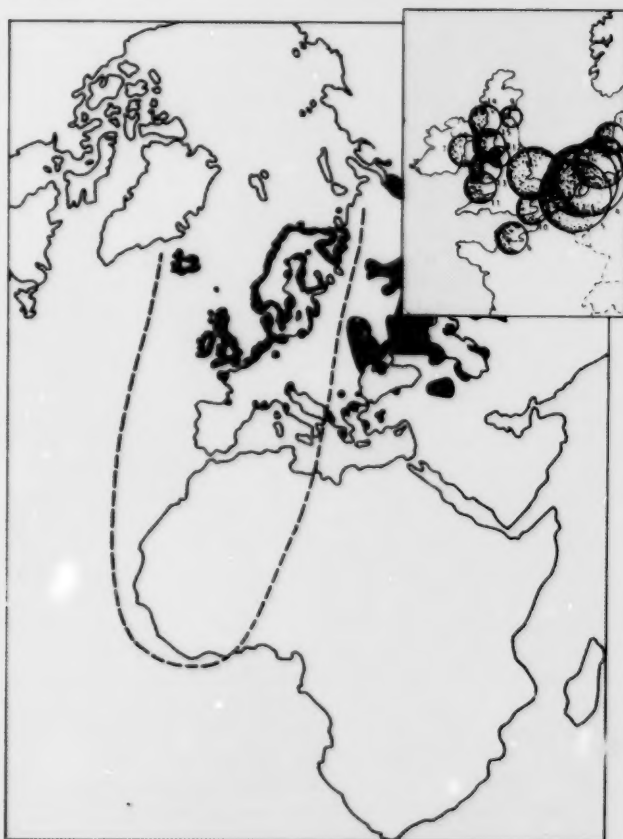
Oystercatchers breed in temperate and subarctic regions in Europe and Asia, mainly along coasts in Europe, but also inland in Asia. In winter, they are found exclusively in coastal habitats. Birds wintering in Britain come mainly from Iceland, the Faeroes, Norway, and Britain; those wintering in the Wadden Sea and the Delta come mainly from the Baltic and White Sea coasts, Scandinavia, and continental northwestern Europe (Pienkowski and Evans 1984). There is a considerable influx of Oystercatchers in northern France, especially in cold winters. Birds wintering in Mauritania belong to the subspecies *H. o. ostralegus* (Swennen 1989); those wintering in Guinea-Bissau are not well studied but look like *ostralegus* as well (E. Wymenga, pers. commun.). The latter birds therefore have also been considered as belonging to the East Atlantic flyway population.

Oystercatcher numbers present in the East Atlantic flyway are estimated at 874 000 birds, 856 000 of these wintering in Europe (Tables 3 and 5). Prater (1976) estimated a total of 558 000 individuals. The higher recent numbers are probably due to an actual increase in population size in northwestern Europe. In The Netherlands, the population has increased steadily over the past decades, rising from 48 000 to 50 000 pairs in 1972-77 (Teixeira 1979) to 70 000 in 1982 (van Dijk 1982) to 90 000 by the mid-1980s (Piersma 1986b). Piersma (1986b) estimated the size of the European breeding population at 218 000 pairs, excluding those from the Soviet Union. This figure, added to the relatively large number of subadult birds in the population, corresponds well with the estimate of the European wintering population.

Sites regularly supporting wintering populations of more than 1% (=9000) of the flyway population are shown in Figure 7. Most of the population winters around the North Sea and Irish Sea. Outside that area, only the numbers at the Banc d'Arguin (7700) come close to the 1% criterion.

Figure 7

Wetlands supporting more than 1% (=9000) of the Oystercatcher population in the East Atlantic flyway. Some wetlands holding numbers slightly below the 1% criterion are also included: Denmark: 1 Vadehavet (16 000); Federal Republic of Germany: 2 Wattenmeer Schleswig-Holstein (65 000), 3 Wattenmeer Niedersachsen (110 000); The Netherlands: 4 Waddenzee (200 000), 5 Delta (107 000); France: 6 Baie Mt. St. Michel (12 000); Ireland: 7 Dundalk Bay (10 000); United Kingdom: 8 Alt. Ribble (9000), 9 Firth of Forth (8000), 10 Thames (12 000), 11 Burry Inlet (17 000), 12 Wash (25 000), 13 Dee (30 000), 14 Solway Firth (36 000), 15 Morecambe Bay (49 000).



7.2. Black-winged Stilt *Himantopus himantopus*

Black-winged Stilts breed from temperate to subtropical and tropical climatic zones, inland as well as along coasts. The species breeds in the Americas, as well as in Eurasia and Africa, and is migratory in the northern part of its breeding range (Cramp and Simmons 1983). Black-winged Stilts are found wintering in Spain and Portugal. Much remains to be discovered about the migratory behaviour and wintering areas of Black-winged Stilts from the East Atlantic flyway. The species is therefore the object of detailed studies supervised by the Wader Study Group (Dubois 1987).

Estimates of the number of wintering Black-winged Stilts on the East Atlantic flyway yield highly unreliable figures regarding population size. The total number found wintering along the western European and West African coasts is about 6000 birds (Table 5). As a result, a wintering site needs only 60 birds to qualify as being "internationally important." The number of sites regularly supporting such numbers is rather large. No less than 19 sites do so, most of them chotts (inland temporary brackish water lakes) in the Magreb countries and coastal lagoons in southwestern Mauritania and in Sénégal.

Estimates based on breeding populations lead to much higher figures. Piersma (1986b) estimated the breeding population in France at 350 to 1410 pairs (but normally 800 to 1000 pairs; Dubois, *in litt.*) and in Portugal at 500 to 2300 pairs. In Spain, numbers have been estimated at 20 000 pairs, in Italy 1130 to 1200 pairs, and in Tunisia 400 to 500 pairs (Cramp and Simmons 1983); however, recent inventories in Spain indicate that 8000 pairs is a more realistic number (L.J. Alberto and P.J. Dubois, pers. commun.). These figures yield a minimum breeding population of approximately 10 000 pairs, producing about 25 000 to 40 000 birds on the wintering grounds. This figure leads to a tentative 1% criterion of 250 birds, which is much higher than the 1% level of 150 suggested by Scott (1982). Apparently, most of the wintering areas of European and North African breeding populations have not yet been found. A large concentration of approximately 10 000 Black-winged Stilts, possibly part of the "missing" birds, has been found wintering around Lake Chad. Additionally, there are concentrations of wintering birds in Lac d'Aleg (Mauritania) and the Niger inundation zone (Jarry *et al.* 1987). When conditions are suitable, up to 10 000 could possibly also be present in the Casamanche, Sénégal (P.J. Dubois, *in litt.*).

Sites regularly supporting "internationally important" (=60) numbers are shown in Figure 8. Not indicated is a wintering population (400 to 700 birds) in southern Spain that is present over a wide area in a large number of small wetlands. Numbers in the Democratic Republic of Guinea (site 19 in Fig. 8) are still unknown but probably range from several hundred to some thousands.

7.3. Avocet *Recurvirostra avosetta*

Avocets breed in temperate, subtropical, and tropical climatic zones in Europe, Asia, and Africa. The most important migration route of northwestern European breeding birds is along the western European coast and extends as far south as West Africa. There are several recoveries from Sénégalambia of breeding birds ringed in Denmark, The Netherlands, and Belgium (Cramp and Simmons 1983). Swedish, Danish, and German breeding birds have been recovered in southeastern France, Italy, and

Tunisia, which suggests overland passage through central Europe. The total number of Avocets wintering in this region amounts to 67 000 birds (Table 5), distributed equally over the western European and West African coasts. Additionally, at least 6000 Avocets winter in the Democratic Republic of Guinea (site 22 in Fig. 9; Altenburg and van der Kamp 1989). These birds leave Guinea by mid-February; their origin is still obscure. There is no evidence for the presence of breeding populations in West Africa, except for occasional breeding in Morocco (Cramp and Simmons 1983; Urban *et al.* 1986). This means that both western and eastern European breeding birds may be involved. Because of this uncertainty and the lack of a complete count, Guinean birds have not been included in the calculations of the size of the East Atlantic flyway population.

The population estimate has more than doubled since Prater's (1976) estimate of 22 000 birds. This does not imply that the true numbers have gone up drastically. In September 1973, 47 000 Avocets were counted in the Dutch Wadden Sea and Delta area (Prater 1976). Also, there are no indications for a population increase in western Europe. The increase noted here seems therefore merely to be the

result of more complete surveys. Numbers found in France have gone up from 7000 to 16 000, and those in Spain from less than 100 to 4200. The number of breeding pairs in western Europe (Piersma 1986b), combined with figures for Italy and the western part of Spain (Cramp and Simmons 1983), yields a total of about 20 000 pairs. Taking into account that there must also be a substantial population of nonbreeding Avocets, this figure corresponds rather well with those from the wintering grounds, including the birds from Mauritania and S  n  gambia.

Sites regularly supporting wintering populations of more than 1% of the East Atlantic flyway population (=700) are shown in Figure 9.

7.4. Common Ringed Plover *Charadrius hiaticula*

In the East Atlantic flyway area, two subspecies can be distinguished:

- (1) *C. h. tundrae* breeds in Lapland and the adjoining arctic and subarctic Soviet Union; and
- (2) *C. h. hiaticula* breeds in temperate, subarctic (western Europe, the Baltic, Iceland), and arctic regions (Svalbard, Greenland, northeastern Canada).

The Common Ringed Plover is often described as a

Figure 8

Wetlands supporting more than 1% (=60) of the Black-winged Stilt population in the East Atlantic flyway: Portugal: 1 Faro (70); Spain: 2 lagoons around Cadiz (70); Morocco: 3 Sidi Moussa-Oualidia complex (500); Algeria: 4 Zemoul (70), 5 Marais de la Macta (100), 6 Chott Ech Chergui (220); Tunisia: 7 Sebket El Djem (80), 8 Sebket El Kourzia (80), 9 Lac de Sedjoumi (100), 10 salines de Thyna (100), 11 Sidi Mansour (100), 12 Sebket El Rherq (400); Mauritania: 13 Aftout es Saheli (1300); S  n  gal: 14 Casamanche (150), 15 coast Dakar-Saloum (250), 16 delta Saloum (800), 17 coast St. Louis-Dakar (600), 18 delta S  n  gal river (1000)

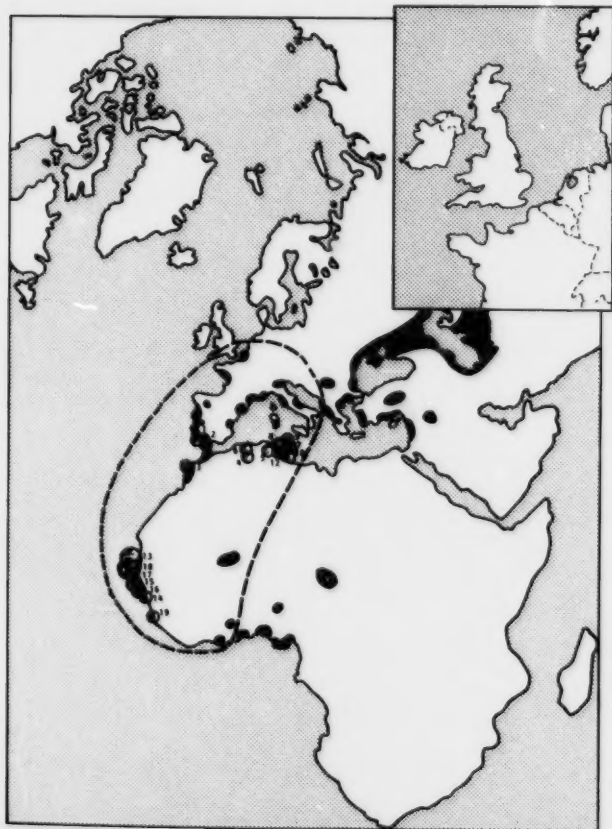
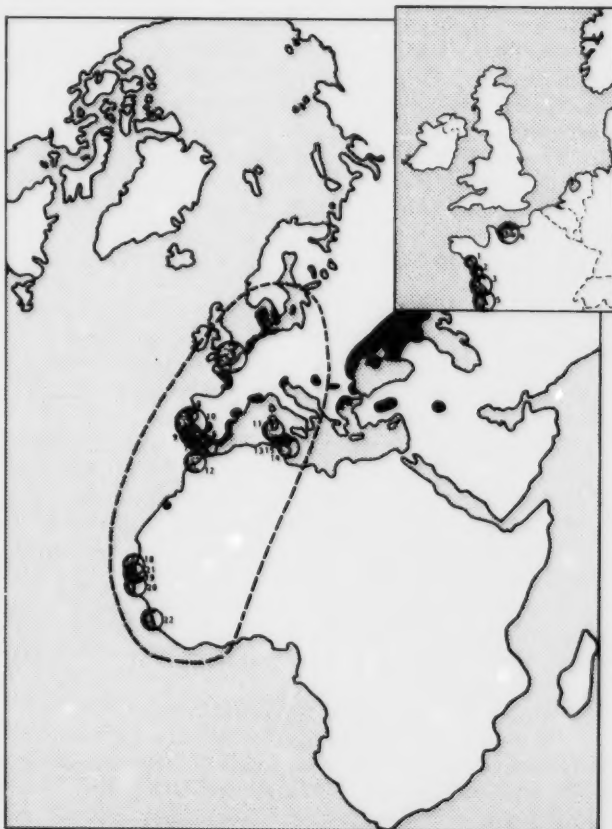


Figure 9

Wetlands supporting more than 1% (=700) of the Avocet population in the East Atlantic flyway. Some wetlands holding numbers slightly below the 1% criterion are also included: France: 1 Baie de Vilaine (600), 2 Baie de Bougneul (900), 3 Loire (2700), 4 Seine (1800), 5 Baie d'Aiguillon (7200); Spain: 6 salines around Cadiz (1200), 7 Marismas Guadalquivir (1200); Portugal: 8 Aveiro (600), 9 Sado (1300), 10 Tejo (10 700); Italy: 11 Stagno di Molentargius (1500); Morocco: 12 Merja Zerga (2200); Tunisia: 13 Lac de Sedjoumi (800), 14 Salines de Thyna (2500), 15 Lac Kelbia (2000); Mauritania: 18 Aftout es Saheli (2500); S  n  gal: 19 coast St. Louis-Dakar (1100), 20 delta Saloum (1100), 21 delta S  n  gal river (7200).



classical example of a species demonstrating leap-frog migration (Salomonsen 1955), i.e., the northernmost breeding birds (arctic Soviet Union) winter farthest south (Africa). Recent analysis of ringing recoveries (Taylor 1980) has shown that this certainly occurs but that there is a greater overlap in wintering areas than previously supposed. Birds breeding in western Europe, including southern Scandinavia, winter largely in western Europe, the western part of the Mediterranean, and Morocco. Birds breeding farther north, both *tundræ* and *hiaticula* (including those from Iceland), winter mainly in West Africa. Some reach Ghana and Benin (Mead and Hudson 1983), and others go even farther south (Taylor 1980). For this reason, the population wintering in Europe and Northwest Africa has been considered distinct from that wintering from West Africa to the Republic of South Africa. The size and migration routes of the latter population are still partly obscure. Nearctic and Icelandic birds migrate along the West African coast, whereas those breeding in the western part of the Soviet Union are thought to cross Europe into North Africa and Arabia. Those breeding between the Urals and the Lena River migrate to the same region as well as farther south into South Africa (Taylor 1980).

The size of the western European, western Mediterranean, and Moroccan wintering population is now estimated at 47 500 birds (Tables 3 and 5), and the West African population at 195 000 birds (including the figures for the western Mediterranean, Ghana, Namibia, and South Africa). The populations in Namibia and on the west coast of South Africa amount to only 3000 birds (Summers *et al.* 1987a). This implies that the great majority of the population does not migrate beyond the Gulf of Guinea. Prater's (1976) total of 42 800 for the whole of the East Atlantic flyway has been boosted to 255 000. The difference for Europe (numbers increasing from 19 800 to 42 500) can be explained primarily by the increase in Ireland, Great Britain, and France, mainly as a result of more complete surveys, in Britain involving the incorporation of numbers wintering in nonestuarine habitats (Summers and Moser 1987). In Africa, the previous estimate for the Banc d'Arguin was 13 000, the recent one 121 000, a difference due totally to more complete surveys. The Arquipelago dos Bijagos is a newly discovered site (Zwarts 1988).

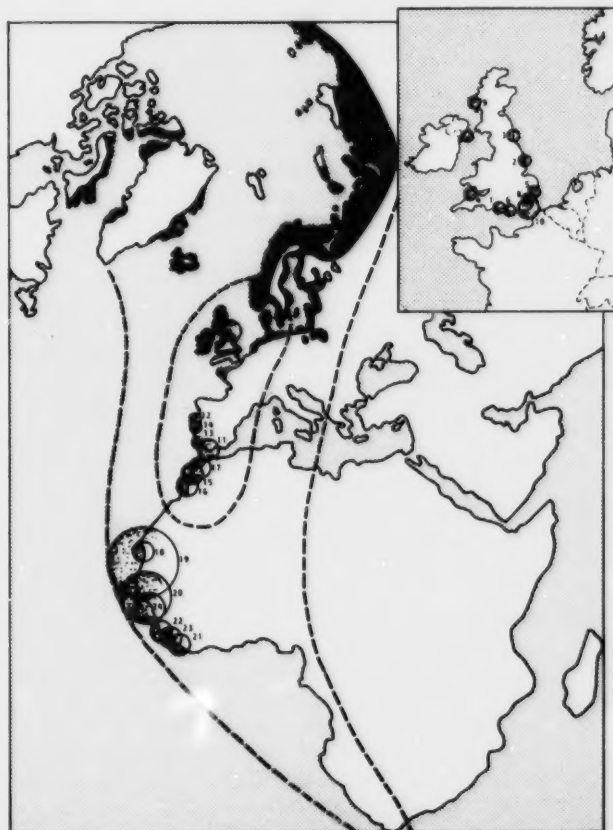
Sites regularly supporting wintering populations of more than 1% (500) of the European, western Mediterranean, and Moroccan population and of the African (1% = 2000) population are shown in Figure 10. Also mapped is Sherbo River in Sierra Leone (site 23 in Fig. 10), from which no complete counts are available. Presumably more than 5000 Common Ringed Plovers will be present there. Numbers in the Democratic Republic of Guinea (site 24) probably qualify as "internationally important" as well, although no complete counts have yet been carried out. Estimates of numbers present on the mudflats during low tide (Altenburg and van der Kamp 1989) yield a preliminary figure in the order of 30 000 to 50 000 birds. These have not been included in the population estimate.

7.5. Snowy Plover *Charadrius alexandrinus*

Most Snowy Plovers ringed on western European shores have been recovered as far south as northwestern Morocco, showing southward movements along the European and Northwest African coast (Cramp and

Simmons 1983). The origin of the relatively large number of Snowy Plovers wintering in West Africa is still somewhat obscure. There is only one recovery linking northwestern European breeding populations to wintering areas in West Africa — a Dutch breeding bird that was recaptured wintering in Guinea-Bissau (Meininger 1988a). The frequency distribution of wing lengths of male Snowy Plovers captured in Tunisia is double-peaked, suggesting that two different populations winter there (van Dijk *et al.* 1986), perhaps a sedentary and a migratory population. Possibly the same holds true for other African wintering sites. The bulk of the East Atlantic flyway population winters along the coast. In addition, small numbers have been found to winter inland around lakes, for instance in northern Nigeria, Chad, Sudan, and Eritrea (Cramp and Simmons 1983). The origin and migration of these birds are obscure. The same applies for the number of pairs that breed in Europe and West Africa. In western Europe, 6400 to 9600 pairs have been registered (Piersma 1986b), but a large part of Spain has not yet been surveyed. The number of breeding pairs in Tunisia is estimated at 5000 (Cramp

Figure 10
Wetlands supporting more than 1% (=500 and 2000) of the two Common Ringed Plover populations in the East Atlantic flyway. Some wetlands holding numbers slightly below the 1% criterion are also included: United Kingdom: 1 6 Langstone/Chichester Harbour (800), 2 Humber (400), 3 Lindisfarne (400), 4 Blackwater/Colne/Denge (400), 5 Orwell/Stour (700), 7 Outer Ards (600), 8 Thames (800), 9 Tiree (800), 10 Medway (1000); Spain: 11 salines around Cadiz (1100); Portugal: 12 Aveiro (600), 13 Faro (700), 14 Tejo (700); Morocco: 15 Sidi Moussa-Qualidia (1400), 16 Sebkhia Tazra (=Puerto Cansado) 2000, 17 Merja Zerga (5000); Mauritania: 18 Baie d'Arguin (5700), 19 Banc d'Arguin (121 000); Guinea-Bissau: 20 Arquipelago dos Bijagos (57 000); Sierra Leone: 21 Yawri Bay (6000), 22 Sierra Leone River (8600), 23 Sherbo River (6000).



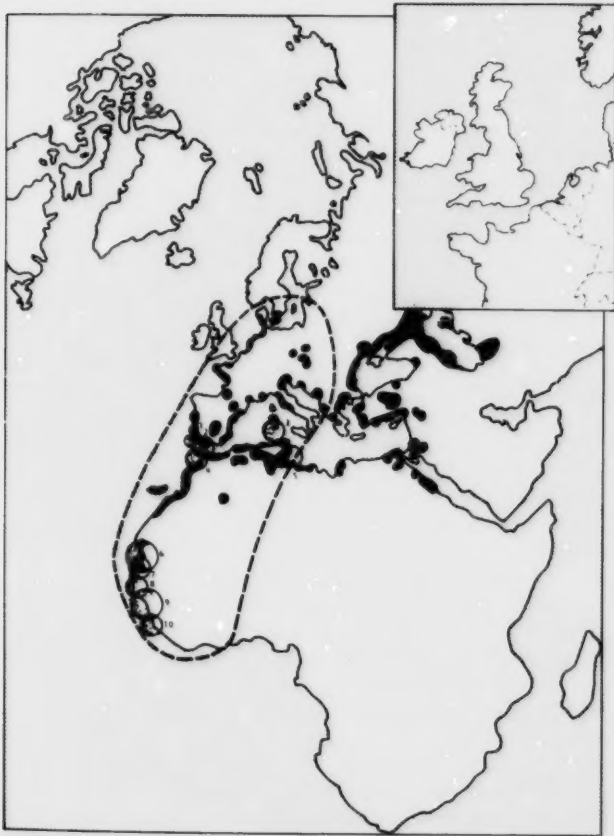
and Simmons 1983).

As so much about the migratory behaviour of populations wintering in Africa and the numbers of breeding pairs is still unknown, the population wintering in southwestern Europe and West Africa has tentatively been considered as a single unit. The size of this population is now estimated at 67 000 birds, 5100 of these wintering in Europe (Table 5). Once again, this is a considerable increase over figures presented by Prater (1976). More complete surveys and the discovery of new wintering areas, for instance in the Mediterranean and in Guinea-Bissau, are the most important reasons for this increase. The 1% criterion for Snowy Plovers amounts to 700 birds. Sites regularly supporting wintering populations exceeding 1% of the total population are shown in Figure 11.

7.6. Black-bellied Plover *Phuialis squatarola*

Traditionally, Black-bellied Plovers visiting wetlands in northwestern Europe were believed to originate from breeding grounds in the arctic Soviet Union, eastward to about 80°E (Taymyr peninsula) (Cramp and Simmons

Figure 11
Wetlands supporting more than 1% (=700) of the Snowy Plover population in the East Atlantic flyway. Some wetlands holding numbers slightly below the 1% criterion are also included: Portugal: 1 Faro (600); Spain: 2 salines near Cadiz (1500); Italy: 3 Stagno de Molentargius (Cagliari) (1500); Morocco: 4 Merja Zerga (2000); Tunisia: 5 Gulf of Gabès (9200); Mauritania: 6 Banc d'Arguin (12 000); 7 Afout es Saheli (6500); Sénégal: 8 delta Saloum (1800); Guinea-Bissau: 9 Arquipélago dos Bijagos (19 000); Sierra Leone: 10 Sierra Leone River (2100).



1983). The wintering areas of these birds reach as far south as the Gulf of Guinea. There are recoveries of birds from the Wash (eastern England), France, Morocco, and Ghana (Branson 1987). Birds wintering in western European wetlands may show a considerable site fidelity to their feeding grounds from year to year (Townshend 1985). Birds migrating towards South Africa are believed to fly via a more easterly route, apparently following the Great Circle Route through the Black Sea area. These birds have been found to carry large fat loads in spring, allowing for a nonstop flight of 6500 km (Summers and Waltner 1979).

In recent years, some new ideas on the origin of Black-bellied Plovers wintering in western Europe and West Africa have been put forward. Using discriminant analysis on biometrical data from captured birds as well as museum skins, Engelmoer (1984) argued that Black-bellied Plovers turning up in northwestern Europe originate from a much wider area than previously thought. According to his data, three populations are present in this region: 10% belong to a short-winged population breeding in north-eastern Canada, 76% to a short-billed and long-winged population from western Siberia, and 14% to a long-winged and long-billed population from central Siberia. An analysis of biometrical data from Mauritania (Smit 1989a) showed large variation in measurements that can hardly be explained by the presence of western Siberian birds alone. The presence of some extremely long-billed and long-winged birds suggests that central Siberian birds are present as winter visitors in Mauritania as well. An even higher proportion of long-billed birds has been captured in Guinea-Bissau (Wymenga *et al.* 1989). There are, however, no recoveries linking the Nearctic breeding grounds to the West African wintering grounds. Obviously, much is still uncertain concerning population composition, migration routes, and wintering areas of Black-bellied Plovers in the East Atlantic flyway. Because of this, birds wintering in western Europe, the western part of the Mediterranean, and West Africa, including the Gulf of Guinea as far east as Ghana, have to be considered as belonging to one population at present. This East Atlantic flyway population, amounting to 168 000 birds (Table 5), yields a 1% level of 1500 birds.

Compared with Prater's (1976) review, Black-bellied Plover numbers in Europe and Africa have gone up dramatically. In western Europe, numbers have increased from 19 800 to 61 200. This increase has been especially pronounced in Great Britain, the Wadden Sea, and the Delta area and can be explained largely by a real increase in numbers present. In Great Britain this increase has been found to occur only in some estuaries, whereas in other areas numbers have remained constant over several years (Moser 1988). Black-bellied Plover numbers in Spain and Portugal have gone up as well, but the increase in these countries is a result of more complete censuses. Most areas in Africa had not been surveyed previously.

Sites supporting wintering populations of more than 1% (=1500) of the East Atlantic flyway population are shown in Figure 12. Numbers present in the Democratic Republic of Guinea (site 21 in Fig. 12) probably qualify as "internationally important" as well, although no complete counts have yet been carried out: estimates of numbers present on the mudflats during low tide yield a preliminary figure in the order of 15 000 birds (Altenburg and van der Kamp 1989). These numbers have not been included in the population estimate.

7.7. Knot *Calidris canutus*

Taxonomists now distinguish four Knot subspecies, two of which are present in the region of the East Atlantic flyway (Cramp and Simmons 1983). Detailed studies organized by the Wader Study Group have revealed much about the migration routes and wintering areas of Siberian (*C. c. canutus*) and Nearctic (*C. c. islandica*) Knots (e.g., Piersma *et al.* 1987b). Both subspecies are capable of migrating over very large distances in single flights. Siberian Knots follow a route along the western European coast to winter in West Africa, using only a small number of wetlands as staging areas (Dick *et al.* 1987). Nearctic Knots winter mainly in countries bordering the North Sea, using wetlands in northern Norway and Iceland in spring as stopover sites (Davidson *et al.* 1986; Uttley *et al.* 1987). Birds wintering in Morocco apparently belong to the Siberian population (Cramp and Simmons 1983), but it is not known whether there is a distinct or a gradual separation in wintering quarters between the two subspecies. Because wintering numbers in southern Europe and North Africa are small, this question is not very relevant to the

calculation of the size of both populations. Assuming that Knots wintering in Europe are *islandica* and those wintering in Africa *canutus*, the European population amounts to 345 000 birds (Table 3), leading to a 1% level of 3500 birds, and the African population amounts to 512 000 birds (Table 5), leading to a 1% level of 5000 birds. The latter figure includes numbers wintering in Ghana, Namibia, and the Republic of South Africa.

Compared with Prater's (1976) review, numbers in Europe have decreased dramatically (from 609 000 to 345 000), despite better survey methods in recent years. This implies that the actual decrease is greater than suggested by these figures. The decrease is particularly striking in France (from 110 000 to 19 000), Britain (350 000 to 218 000), and Ireland (55 000 to 30 000), and less so in the Wadden Sea (65 000 to 58 000) and the Delta area (14 000 to 15 000). There has been some speculation on the cause of this decrease. It has been suggested that a series of bad breeding seasons is the main cause (Green *et al.* 1977; Pienkowski and Evans 1984). Habitat changes and land reclamation at wintering sites may also have been involved. Numbers in Africa have gone up considerably since Prater's (1976) review (135 000 to 512 000), but this increase is entirely due to better survey coverage and the discovery of new wintering sites, such as the Arquipelago dos Bijagos in Guinea-Bissau.

Sites regularly supporting wintering populations exceeding 1% of the population are shown in Figure 13.

Figure 12

Wetlands supporting more than 1% (=1500) of the Black-bellied Plover population in the East Atlantic flyway: United Kingdom: 1 Dee (1600), 2 Langstone/Chichester Harbour (1900), 3 Alt/Ribble (1600), 4 Swale (2000), 5 Thames (2800), 6 Wash (4200); The Netherlands: 7 Waddenzee (2500), 8 Delta (7200); France: 9 Baie de Bourgneuf (1700), 10 Baie Mt. St. Michel (2100), 11 Baie de l'Aiguillon (2800); Portugal: 12 Tejo (4800); Italy: 13 N Adriatic wetlands (1500); Morocco: 14 Merja Zerga (2000), 15 Sebka Tazra (=Puerto Cansado) (3000); Tunisia: 16 Gulf of Gabès (20 000); Mauritania: 17 Banc d'Arguin (18 000); Guinea-Bissau: 18 Arquipelago dos Bijagos (57 000); Sierra Leone: 19 Sierra Leone River (2300), 20 Yawri Bay (3500)



7.8. Sanderling *Calidris alba*

Sanderlings are long-distance migrants that may cross the continental Soviet Union and Europe at altitude to turn up again on maritime coasts. Ringing recoveries of birds captured in the Wash, on the English east coast, range from eastern Greenland and the Lena River delta in the north to the extreme southern tip of the Republic of South Africa in the south (Branson 1987). These recoveries show that birds seen in western Europe and West Africa originate from the Nearctic as well as from Siberian breeding grounds. There are some indications in Britain of Siberian birds moulting flight feathers in northwestern Europe and subsequently wintering, whereas Nearctic birds only stage for some weeks to deposit fat before leaving (Cramp and Simmons 1983). This means that Siberian birds winter in western Europe, whereas Nearctic birds only pass through in autumn and spring to winter in Africa.

The presence of Siberian birds in South Africa, however, demonstrates that the actual situation is far more complex. South African wintering birds follow routes through western Europe in autumn as well as through the Caspian and Black seas, but little is known about their route through Africa. During spring migration, South African birds turn up in the North Sea area, the Mediterranean, and the Caspian Sea (Summers *et al.* 1987b). Biometrical information from Mauritania indicates that birds belonging to both populations are present (Smit and van Spanje 1989). Apparently, the two populations mix in their wintering areas, at least to some extent. For this reason, all birds wintering from northwestern Europe to South Africa have been here considered as one population, the size of which is now estimated at 123 000 birds (Table 5). Because the species is also likely to occur frequently on sandy beaches along the whole West African coast, which has not yet been surveyed, this number should increase as soon as results from such counts become

available. For the moment, the 1% criterion has been set at 1000 birds.

Numbers in the area of the East Atlantic flyway have increased considerably since Prater's (1976) review, mainly as a result of more complete surveys and the discovery of new concentrations of birds. Numbers in Europe have increased from 10 000 to 27 000 birds, and those in Africa from 16 000 to 96 000. Sites regularly supporting wintering populations exceeding 1% of the population are shown in Figure 14.

7.9. Little Stint *Calidris minuta*

Little Stints breed in arctic and high-arctic regions in northern Scandinavia and the Soviet Union and winter in subtropical and tropical Africa, Arabia, and South Asia (Cramp and Simmons 1983). They winter on coastal mudflats, creeks, and estuaries, as well as in shallow inland wetlands (Urban *et al.* 1986). Migration occurs over a broad front. Little Stints may use a wide variety of habitats as stopover sites. Finnish- and Swedish-ringed migrants have been recovered throughout western and central Europe,

Italy, Mediterranean France, and Tunisia (Cramp and Simmons 1983; Roos 1984), and birds from the southern Baltic and Black Sea have been recovered in West Africa (Gromadzka and Kania, in Ilychev 1985). Little Stints ringed in the West African wintering quarters (Sénégal) and Tunisia show the reverse pattern, being recovered from the central Mediterranean to the Black Sea and Finnmark, to 64°E (Moreau 1967; Cramp and Simmons 1983). Birds wintering in South Africa pass through the Caspian Sea and the Kazakhstan lakes (Cramp and Simmons 1983; Gromadzka and Kania, in Ilychev 1985), apparently following a route through the Rift Valley lakes in East Africa (Summers and Waltner 1979). Birds ringed at the Yugorskiy peninsula have been recovered in Tunisia as well as in South Africa. In spring, Little Stints wintering in West Africa tend to use a somewhat more easterly route through the northeastern Sahara and the Mediterranean (Cramp and Simmons 1983).

In the past few years, some quantitative information has become available on the number of Little Stints wintering in African inland habitats. According to Urban

Figure 13
Wetlands supporting more than 1% (=3500 and 5000) of the two Knot populations in the East Atlantic flyway: Federal Republic of Germany: 1 Wattenmeer Schleswig-Holstein (5000), 2 Wattenmeer Niedersachsen (3000); The Netherlands: 3 Waddenze (50 000), 4 Delta (15 000); Ireland: 5 North Bull (8000); United Kingdom: 6 Strangford Lough (13 000), 7 Duddon (4000), 8 Montrose Basin (4000), 9 Blackwater/Colne/Dengie (5100), 10 Burry Inlet (5000), 11 North Norfolk marshes (5000), 12 Tees (6000), 13 Solway (7000), 14 Firth of Forth (11 000), 16 Dee (21 000), 17 Thames (21 000), 18 Morecambe Bay (25 000), 19 Humber (29 000), 15/20 Ribble/Alt (47 000), 21 Wash (88 000); France: 22 Baie de l'Aiguillon (4600), 23 Baie Mt. St. Michel (5000); Mauritania: 24 Baie d'Arguin (27 000), 25 Banc d'Arguin (335 000); Guinea-Bissau: 26 Arquipélago dos Bijagos (144 000)

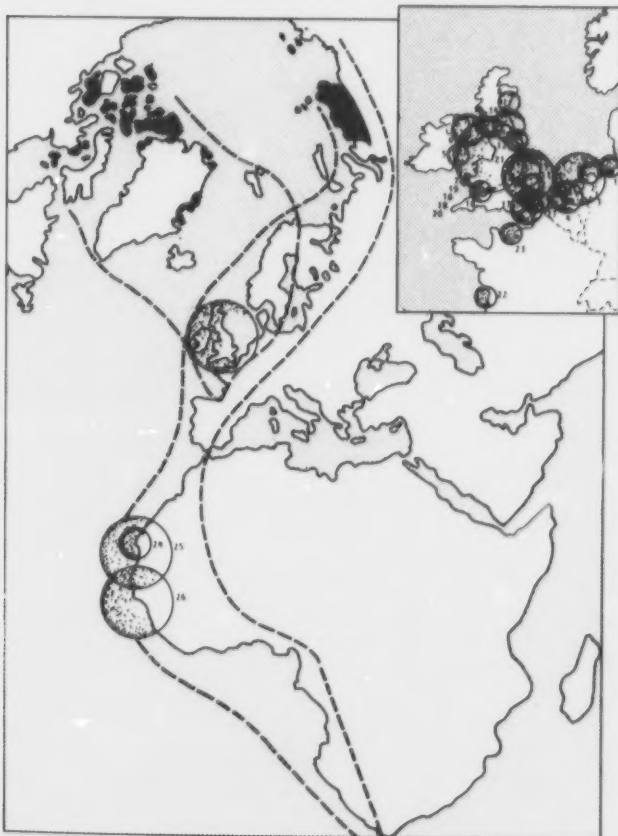
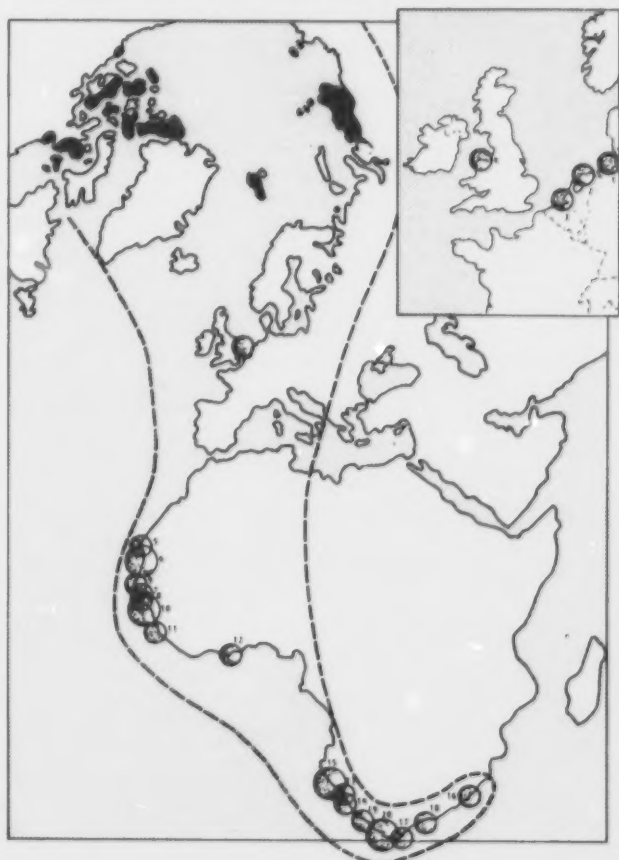


Figure 14
Wetlands supporting more than 1% (=1000) of the Sanderling population in the East Atlantic flyway: Federal Republic of Germany: 1 Wattenmeer Niedersachsen (1500); The Netherlands: 2 Waddenze (2000), 3 Delta (1100); United Kingdom: 4 Alt/Ribble (2000); Mauritania: 5 Presqu'île de Cap Blanc (2000), 6 Banc d'Arguin (19 000); Sénégal: 7 coast between Dakar and delta Saloum (1500), 8 delta Saloum (2000), 9 coast St. Louis-Dakar (2500); Guinea-Bissau: 10 Arquipélago dos Bijagos (11 000); Sierra Leone: 11 Sierra Leone River (2900); Ghana: 12 whole coastline (4600); Namibia: 13 Walvis Bay (8300), 14 Sandvis (8800), 15 coast N Namibia (15 000); Republic of South Africa: 16 coast Natal (1800), 17 southern part Cape Province (2300), 18 eastern part Cape Province (6900), 19 northern part Cape Province (7500), 20 western part Cape Province (13 000)



et al. (1986), some hundreds of thousands winter along freshwater and soda lakes in Ethiopia and East Africa. G. Nikolaus (in Summers *et al.* 1987a) estimated the numbers in Sudan at 250 000 to 500 000. Numbers wintering elsewhere in the North African tropical belt are as yet unknown, but it is evident that these numbers exceed those from coastal wetlands. Numbers wintering on the coast in West Africa are estimated at 211 000 birds (Table 5), leading to a 1% criterion of 2000 birds. Sites in the area of the East Atlantic flyway holding wintering populations exceeding this 1% level are depicted in Figure 15. Numbers in the Democratic Republic of Guinea (site 11 in Fig. 15) have not yet been surveyed adequately; however, according to a few density estimates during low tide, some ten thousand Little Stints are present (Altenburg and van der Kamp 1989). Compared with Prater's (1976) review, there has been a considerable increase in Little Stint numbers. This is particularly so in West Africa and results from new censuses in areas that were previously poorly known.

Figure 15

Wetlands supporting more than 1% (=2000) of the Little Stint population in the East Atlantic flyway: Tunisia: 1 Gulf of Gabès (20 000); Italy: 2 Stagno di Molentargio (4000), 3 N Adriatic wetlands (8000); Mauritania: 4 Gorgol (3100), 5 Aftout es Saheli (8000), 6 Banc d'Arguin (23 000); Sénégal: 7 coast between the main river deltas (2400), 8 delta Saloum (3500), 9 Sénégal delta (7500); Guinea-Bissau: 10 Arquipélago dos Bijagos (123 000)

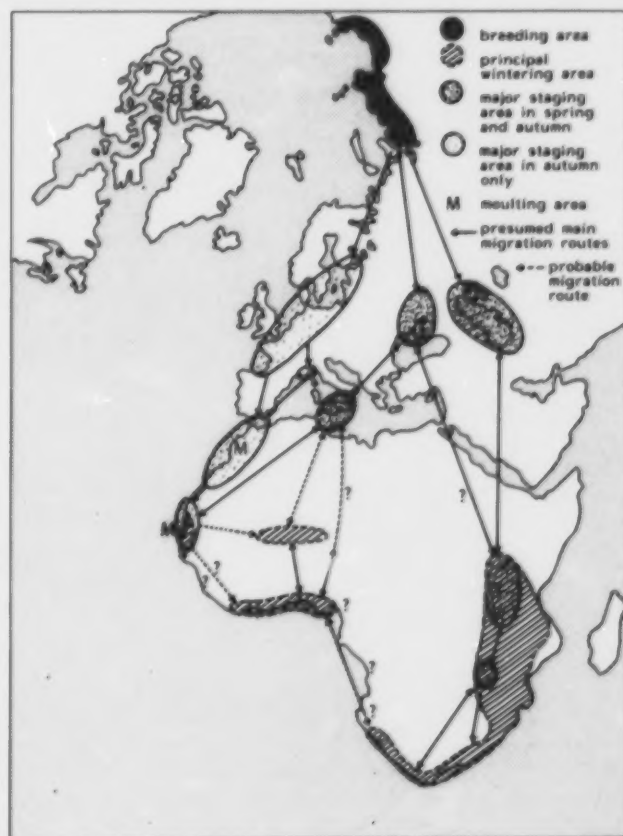


7.10. Curlew Sandpiper *Calidris ferruginea*

Curlew Sandpipers are long-distance migrants that breed only in a relatively small part of the high-arctic Soviet Union; their wintering area covers the African, Arabian, and Australian coasts (Cramp and Simmons 1983). Although many routes may not yet have been documented, some major migration patterns have been found, based upon our knowledge of wintering areas as well as on ringing recoveries (Fig. 16). Birds appear to migrate via western Europe and the Black Sea/Tunisia, both routes leading to West Africa. Another population uses stopover sites in the Black Sea/Caspian Sea, the Rift Valley lakes, and South Africa (Wilson *et al.* 1980). Curlew Sandpiper numbers in western Europe in spring are much smaller than those in autumn. Obviously, the birds follow a more easterly route when returning to the breeding areas (Cramp and Simmons 1983). Numbers in western Europe are highly variable between years, a phenomenon often linked to easterly winds (Stanley and Minton 1972) as well as major differences in breeding success between years (Underhill 1987).

Figure 16

Schematic summary of the major migration system of Curlew Sandpipers in Europe and Africa (after Wilson *et al.* 1980)



As most Curlew Sandpipers wintering in South Africa migrate via East Africa (Summers and Waltner 1979), the wintering area of birds from the East Atlantic flyway population has been considered to cover western Europe and West Africa, including the northern shores of the Gulf of Guinea. At present, the size of this population is estimated at 436 000 birds (Table 5), leading to a 1% level of 4500. Only a few sites qualify at this level (Fig. 17). All sites but one are situated on the West African coast at 20°N or farther south. Numbers present in the Democratic Republic of Guinea (site 5 in Fig. 17) probably qualify as "internationally important" as well, but no complete counts have been carried out so far. Estimates of numbers present on the mudflats during low tide (Altenburg and van der Kamp 1989) yield a preliminary figure in the order of 50 000 birds. These numbers have not yet been included in the population estimate.

7.11. Purple Sandpiper *Calidris maritima*

Purple Sandpipers are extraordinary because they winter farther north than any other wader and because they

Figure 17
Wetlands supporting more than 1% (=4500) of the Curlew Sandpiper population in the East Atlantic flyway: Tunisia: 1 Gulf of Gabès (5000); Mauritania: 2 Baie d'Arguin (13 000); 3 Banc d'Arguin (145 000); Guinea-Bissau: 4 Arquipélago dos Bijagos (219 000); Sierra Leone: 5 Yawri Bay (10 000); 7 Sierra Leone River (17 000)



winter largely on rocky shores, generally not in large flocks. In Britain, estuaries hold less than 5% of the wintering population (Moser 1987). The wintering area of the species extends from southern Greenland, Iceland, northern Scandinavia, and the Kola peninsula in the north to western France in the south (Cramp and Simmons 1983), although small numbers can also be found in northern Spain (Table 3). Rocky shores are very often difficult to census. An additional problem is that rocky shores in northern Scandinavia, Iceland, and Greenland, as well as locally in western Europe, are situated mainly in thinly populated areas. Consequently, knowledge of wader numbers wintering in this habitat is scarce. Detailed information on numbers wintering on the coasts of Britain and Northern Ireland yields a figure of 15 800 Purple Sandpipers (Moser and Summers 1987). This is probably an underestimate of numbers actually present. Nicoll *et al.* (1988) estimated that in normal winters approximately 20 000 are present. This figure, combined with data from elsewhere in western Europe and Iceland, leads to a total of 32 400 birds for the whole area (Table 3). Purple Sandpipers are the most common wader species on Norwegian coasts, numbers in Norway and Iceland being "tens of thousands" (Cramp and Simmons 1983). Except for some counts in southwestern Iceland (Wilson 1982) and a report of them "sometimes occurring in concentrations of up to 1000 individuals" on the coast in central Norway (Folkestad 1975), no detailed information is available on Purple Sandpiper distribution in these countries.

Migration patterns of Purple Sandpipers are highly complicated and incompletely understood. Birds of no less than three different populations appear to be present in western Europe. These populations cannot be separated in the field but can be, to some extent, in the hand. Using bill and wing measurements, Atkinson *et al.* (1981), Boere *et al.* (1984), and Nicoll *et al.* (1988) tried to unravel these complicated patterns. It appears that short-billed Scandinavian breeding birds migrate mainly toward the English east coast to winter. Scotland and northwestern England are predominantly populated by long-billed birds, whose origin is still partly obscure, although there are indications that they originate from northeastern Canada, using Iceland as a stopover site during migration. The Netherlands and southeastern England may hold some of these birds as well, although recoveries from stopover sites in Sweden also point toward the presence of long-billed birds from the Soviet Union. Purple Sandpipers from eastern Greenland are believed to winter in Iceland, and birds from western Greenland have been found to remain in western and southern Greenland, close to their breeding areas (Cramp and Simmons 1983).

Because of our insufficient knowledge of population sizes and migration patterns, the East Atlantic flyway population is provisionally estimated at 50 000 birds, leading to a preliminary 1% criterion of 500 birds. Sites holding "internationally important" numbers are shown in Figure 18.

7.12. Dunlin *Calidris alpina*

Four Dunlin populations can be distinguished in the East Atlantic flyway, all showing consistent migration strategies, with partly or totally overlapping wintering areas and stopover sites (Fig. 19). These populations differ considerably in size: *C. a. arctica*, breeding on Greenland, and the temperate *C. a. schinzii* population, breeding on the British Isles and in the southern Baltic, are far less numerous than the Icelandic *schinzii* and the Eurasian *alpina* populations. Dunlin migration has been studied intensively (Leslie and Lessells 1978; Hardy and Minton 1980; Greenwood 1984; Gromadzka, in Ilychev 1985; Jönsson 1986). These studies led to a division of wintering areas as shown in Figure 19 and Table 8, as well as the incorporation of the whole Mediterranean as part of the East Atlantic flyway. The latter has been done on the basis of recoveries from southern Scandinavia and the Black Sea area, pointing toward southeastern movements within a given year (Greenwood 1984; Gromadzka, in Ilychev 1985).

The total population size of Dunlins in the East Atlantic flyway, including the whole Mediterranean,

amounts to 2.2 million birds (Table 5). From our knowledge of the wintering areas and the size of the distinct breeding populations, we have produced 1% levels for each of the four populations (Table 8). The number of *schinzii* breeding on Iceland is estimated at 100 000 to 300 000 pairs (Piersma 1986b). Taking the highest estimate and assuming that one pair of Dunlins produces one first-calendar-year bird on the wintering grounds, we arrive at a population of somewhat over 900 000 birds. This figure corresponds well with the estimate of around 800 000 Dunlins wintering in West Africa, including Morocco. One major wetland in West Africa has not been counted to date — the Baia de Rio de Oro in the western Sahara — and it may eventually "supply" us with the 100 000 "missing" Dunlins. The major wintering area of the small *arctica* population undoubtedly is the Banc d'Arguin. Dick (1975) estimated that at most 5% of the number present there consisted of this subspecies. At present, there are no sites known to hold substantial wintering populations of temperate *schinzii*. This is because *C. a. alpina* and *C. a. schinzii* cannot be separated in the field, and

Figure 18

Wetlands supporting more than 1% (= 500) of the Purple Sandpiper population in the East Atlantic flyway: Iceland: 1 SW Iceland (2000); Faeroes: 2 whole island group (1000); United Kingdom: 3 Northumberland (500), 4 Loshian coast (500), 5 Strathclyde coast (500), 6 Lewis and Harris coast (800), 7 Uists (1200), 8 Shetlands (1500), 9 Highland coast (1600), 10 Grampian coast (1600), 11 Orkneys (5700); France: 12 Bretagne (1750)



Figure 19

Winter distribution of Dunlin populations on the East Atlantic flyway: 1 = *arctica*, 2A = Icelandic *schinzii*, 2B = temperate *schinzii*, 3 = *alpina* (modified after Jönsson 1986)

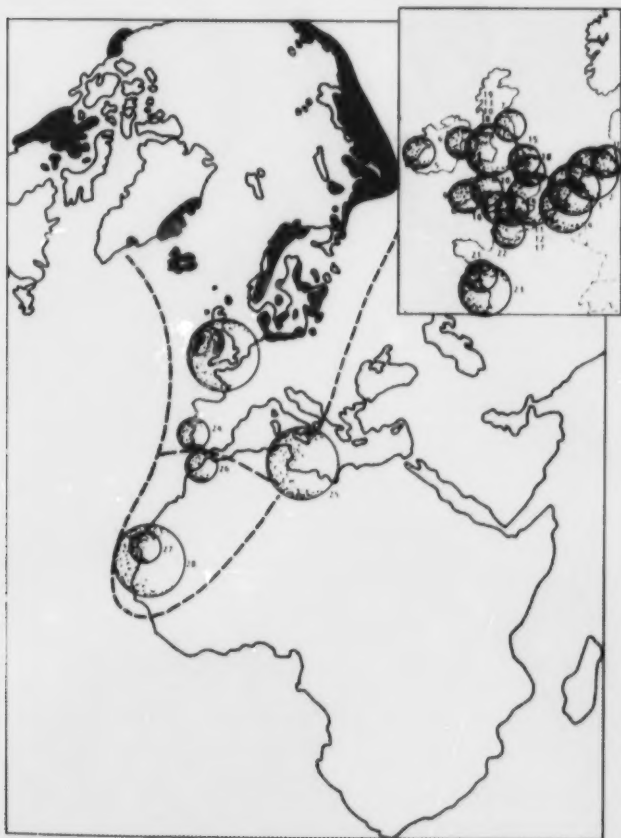


Table 8
Breeding and wintering areas and population sizes of four populations of Dunlins (data from Jönsson 1986; Piersma 1986b; Cramp and Simmons 1983; and simultaneous wader counts [this paper])

Species	Breeding area	Wintering area	Population size*	1% level
<i>C. a. arctica</i>	NE Greenland	W Africa	15 000	150
<i>C. a. schinzii</i> (western population)	Iceland, SE Greenland	W Africa	800 000	8000
<i>C. a. schinzii</i> (temperate population)	Baltic UK, Ireland	SW Europe NW Morocco	21 000	200
<i>C. a. alpina</i>	USSR, arctic Scandinavia	Europe, NW Morocco, Mediterranean	1 373 000	13 000

*The population size for "arctica" is based upon an estimate (5000 pairs) from the breeding areas, whereas others are based upon results from censuses and the division of wintering areas as shown in Figure 19.

Figure 20
Wetlands supporting more than 1% (=14 000 and 8000) of the two major Dunlin populations in the East Atlantic flyway. Some wetlands holding numbers slightly below the 1% criterion are also included: Federal Republic of Germany: 1 Wattenmeer Schleswig-Holstein (20 000), 2 Wattenmeer Niedersachsen (65 000); The Netherlands: 3 Waddenzee (90 000), 4 Delta (91 000); Ireland: 5 Shannon (25 000); United Kingdom: 6 Dundalk Bay (15 000), 7 Lindisfarne (13 000), 8 Alt. Ribble (15 000), 9 Blackwater/Cole/Dengie (26 000), 10 Dee (16 000), 11 Orwell/Stour (34 000), 12 Medway (17 000), 13 Mersey (26 000), 14 16 Chichester/Langstone Harbour (55 000), 15 Humber (26 000), 17 Thames (28 000), 18 Wash (35 000), 19 Morecambe Bay (35 000), 20 Severn (46 000); France: 21 Golfe de Morbihan (23 000), 22 Baie Mt. St. Michel (28 000), 23 Basin d'Arcachon (50 000); Portugal: 24 Tejo (27 000); Tunisia: 25 Gulf of Gabès (125 000); Morocco: 26 Merja Zerga (20 000); Mauritania: 27 Baie d'Arguin (35 000), 28 Banc d'Arguin (710 000).



biometrics of the species are partly overlapping. Better techniques are necessary to discriminate between the two groups. Wetlands holding "internationally important" numbers of Icelandic *schinzii* and *alpina* are shown in Figure 20.

Compared with data from Prater's (1976) review, there has been a considerable decrease in Dunlin numbers in Britain and Ireland. One possible reason for this decrease is explained in Section 11.2. Elsewhere in Europe, there has been some increase in numbers, probably as a result of more complete censuses. As a whole, numbers in Europe have changed only very little. Dunlins were and still are the most numerous coastal wader species in Europe. There is, however, some concern about the decrease of Baltic temperate *schinzii*. Considering that these birds use wetlands in southwestern Europe and northern Morocco, where their occurrence and biology have been studied insufficiently, we may conclude that more detailed information on this population outside its breeding areas is a priority. Known Dunlin numbers in the Mediterranean and in West Africa have increased sharply, as a result of counts in previously incompletely surveyed areas.

7.13. Black-tailed Godwit *Limosa limosa*

There are two subspecies of the Black-tailed Godwit present on the East Atlantic flyway: *L. l. islandica* breeds mainly in Iceland, occasionally also on the Faeroes, and *L. l. limosa* breeds in temperate regions from northwestern Europe to the Kazakhstan SSR (Cramp and Simmons 1983). In Iceland, the *islandica* population has spread steadily from the early part of this century and has recently colonized the northern part of the island. *Limosa l. limosa* has a major stronghold in The Netherlands (Piersma 1986b). Beintema and Drost (1986) recently reviewed the migration system of Black-tailed Godwit populations. Icelandic birds winter in Britain and Ireland and along the Atlantic coasts of France, Spain, and Portugal, with some reaching Morocco. These birds are found mainly on coastal wetlands, where they mix with birds from the western population of *limosa*, especially in Morocco and on inland wetlands in Spain. Western populations of *limosa* migrate down the Atlantic coast to tropical Africa, whereas eastern European populations cross the Mediterranean and the Sahara. The latter populations probably also winter in tropical Africa, from Mali and Lake Chad eastwards (Beintema and Drost 1986). The origin of the wintering populations in Mediterranean Spain (Ebro delta, mean number 1750 birds over 1973-80; Smit 1986) and Tunisia (Gulf of Gabès, 1700; van Dijk *et al.* 1986) is still obscure. Eastern and western birds are separated by a demarcation line running from southwest to northeast through Germany, Poland, and the Baltic states. The easternmost population of *L. l. limosa*, breeding in Kazakhstan SSR, winters in India (Beintema and Drost 1986).

Because the western population of *L. l. limosa* winters mainly inland, we have included only *L. l. islandica*, which winters in coastal wetlands on the Atlantic coast from northwestern Europe to northern Morocco. The size of this population is about 65 000 birds, leading to a 1% criterion of 700 birds. Because some of the birds wintering in southern Spain and northern Morocco probably also consist of *limosa*, the real 1% level may very well be lower than 600. Therefore, Figure 21 depicts all sites holding regular wintering populations of 400 birds and more. Present estimates of the size of the Icelandic breeding

population amount to 10 000 to 30 000 pairs (Piersma 1986b), leading to a wintering population of roughly 25 000 to 90 000 birds. A population of 50 000 birds in coastal wetlands on the Atlantic coast of Europe and Morocco fits well within this range. The previous estimate of Black-tailed Godwit numbers (Prater 1976) was 40 000 birds in Europe and an additional 30 000 in Morocco. This number was considered by A. Gardarsson (in Cramp and Simmons 1983) to be "probably much too high" relative to the number of breeding pairs in Iceland. Although Black-tailed Godwits have increased in number in Iceland, this may still apply. It is therefore not unlikely that part of the Black-tailed Godwit population wintering in Spain consists of *limosa*.

7.14. Bar-tailed Godwit *Limosa lapponica*

The nominate race of the Bar-tailed Godwit breeds in subarctic and high-arctic habitats from Lapland to the eastern part of the Taymyr peninsula. This population

occurs in western Europe and West Africa. *Limosa l. baueri*, which breeds farther east in the Soviet Union and in Alaska, winters in Southeast Asia and Australia (Cramp and Simmons 1983). Migration routes of the 2300 Bar-tailed Godwits that winter on the Namibian coast (Summers *et al.* 1987a) are not yet known, although there is a recovery of a South African-ringed bird from Iran (Cramp and Simmons 1983). This suggests that Bar-tailed Godwits wintering in South Africa pass through the Caspian Sea area. Bar-tailed Godwits are long-distance migrants, using only a limited number of stopover sites. Migration patterns, origin of breeding populations, and the location of wintering areas, however, are still only partly understood.

Figure 22 shows that within the area of the East Atlantic flyway there is a clear segregation in wintering areas — one group of Bar-tailed Godwits winters mainly around the North Sea, another group mainly along the West African coast. Birds wintering in Portugal arrive relatively late in autumn, probably after having moulted in

Figure 21

Wetlands supporting more than 1% (=700) of the *L. l. islandica* population in the East Atlantic flyway. Some wetlands holding numbers slightly below the 1% criterion are also included: Ireland: 1 Dungarvan Harbour (900), 2 Ballymacoda Bay (1000), 3 Wexford Harbour (1500), 4 Cork Harbour (2000); United Kingdom: 5 Swale (400), 6 Poole Harbour (600), 7 Exe (700), 8 Hamford Water (700), 9 Solent (600), 10 Dee (700), 11 Chichester/Langstone Harbour (1100), 12 Orwell/Stour (1100), 13 Alt/Ribble (1500); France: 14 Baie Mt. St. Michel (1000), 15 Baie de l'Aiguillon (6600); Portugal: 16 Sado (500), 17 Faro (700), 18 Tejo (5600); Spain: 19 salines and lagoons around Cadiz (1600), 20 Marismas Guadalquivir (2600); Morocco: 21 Merja Zerga (10 000).

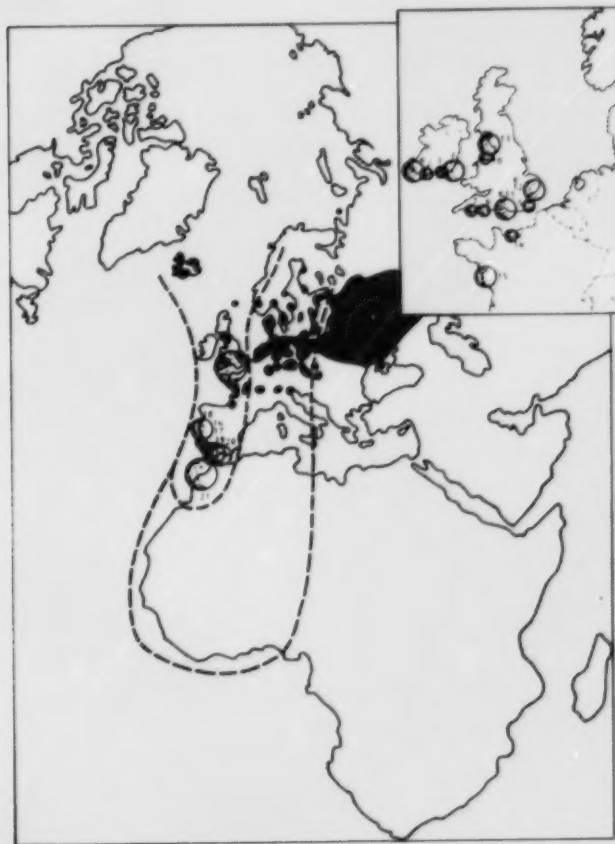


Figure 22

Wetlands supporting more than 1% (= 1000 and 7000) of the two Bar-tailed Godwit populations in the East Atlantic flyway: Denmark: 1 Vadehavet (1100); Federal Republic of Germany: 2 Wattenmeer Niedersachsen (1000), 3 Wattenmeer Schleswig-Holstein (3000); The Netherlands: 4 Waddensee (20 000), 5 Delta (7900); Ireland: 6 Dublin Bay (2000), 7 Dundalk Bay (6500); United Kingdom: 8 Langstone/Chichester Harbour (2200), 9 Strangford Lough (1100), 10/15 Inner Moray/Findhorn/Culbin/Nairn (2100), 11 Dornoch Firth (1200), 12 Humber (1400), 13 Eden (1500), 14 Firth of Tay (1600), 17 Thames (6500), 18 Lough Foyle (3300), 19 Firth of Forth (4500), 20 Morecambe Bay (4900), 21 Solway (6000), 22 Lindisfarne (6500), 23/25 Alt/Ribble (17 000), 24 Wash (8600); France: 26 Baie de l'Aiguillon (1000), 27 Baie de Bourgneuf (1100), 28 Baie Mt. St. Michel (1500), 29 Baie de St. Brieux (1600); Portugal: 30 Tejo (1600), 31 Aveiro (1700), 32 Faro (1800); Mauritania: 33 Banc d'Arguin (537 000); Guinea-Bissau: 34 Arquipelago dos Bijagos (156 000).



wetlands farther north. Maximum numbers in Faro are present from January to March, decreasing rapidly again shortly thereafter (Rufino and Araujo 1987). These birds therefore show the same migration behaviour in spring as the ones wintering in northwestern Europe. They also use northwestern European wetlands as stopover sites, which is particularly obvious in spring. Bar-tailed Godwit numbers on British estuaries decrease considerably in March, and in April and May numbers are even lower (Prater 1981a). In the Wadden Sea, birds that have wintered in the area leave from March onwards, but they are soon replaced by birds that have wintered farther south. Peak numbers in the Dutch part of the Wadden Sea are reached in early May (78 000) (Smit and Wolff 1981; de Goede *et al.* 1985). The apparent existence of distinct wintering areas and migration strategies is the reason for distinguishing two separate populations within the area of the East Atlantic flyway. The breeding areas of these birds are still somewhat obscure, although there are indications, based on biometrics, that most birds wintering in western Europe originate from northern Scandinavia eastwards to the White Sea (Engelmoer 1984, and unpubl. data; de Goede *et al.* 1985).

Biometrics of the Bar-tailed Godwit, however, still pose a problem. It is very likely that these patterns are more complicated than suggested by Cramp and Simmons (1983). The concept of a clinal transition in bill and wing measurements, with Bar-tailed Godwits that breed farther east being larger (Cramp and Simmons 1983) and darker coloured (Glutz von Blotzheim *et al.* 1977), appears to be too simple. Reanalysis of the biometrics of different populations in northern Scandinavia and the Soviet Union has shown that wing and bill measurements of northern Scandinavian birds are larger than those of western Siberian birds but smaller than those of central Siberian Bar-tailed Godwits. A more detailed analysis is currently being undertaken (Engelmoer, unpubl. data).

Because of the Portuguese findings, we use the Strait of Gibraltar provisionally as the border between the "European" and the "African" wintering populations. The size of the European population is estimated at 115 000 birds (Table 3), yielding a 1% criterion of 1000 birds. Sites supporting this number are shown in Figure 22. The African wintering population is now estimated to be at least 700 000 birds, including Tunisia (Table 5), yielding a 1% criterion of 7000 birds. Only two sites qualify as "internationally important," indicating their very considerable nature conservation value. Numbers present in the Democratic Republic of Guinea (site 35 in Fig. 22) probably qualify as "internationally important" as well, but no complete counts have been carried out in this country so far. Estimates of numbers present on the mudflats during low tide (Altenburg and van der Kamp 1989) yield a preliminary figure of some tens of thousands. These numbers have not yet been included in the population estimate. Compared with Prater's (1976) review, the population estimate has more than doubled, mainly as a result of the recent discovery of important wintering populations in West Africa.

7.15. Whimbrel *Numenius phaeopus*

The nominate subspecies of the Whimbrel breeds in boreal and subarctic habitats from Iceland to western Siberia, including the Faeroes, Shetlands, and Fennoscandia. Other subspecies breed farther east in the

Soviet Union and in North America. The nominate subspecies winters almost exclusively in coastal regions, in Africa, in Arabia, and along the Indian Ocean. Migration occurs overland in a broad front, overflying large areas but involving only a very limited number of staging areas (Cramp and Simmons 1983). These may be found on the coast (Trolliet 1985) as well as inland, for instance in The Netherlands and Hungary (Cramp and Simmons 1983). Birds from Iceland, the Faeroes, Fennoscandia, and the northwestern Soviet Union winter mainly in West Africa (Cramp and Simmons 1983). Recoveries of Belgian-, British-, and Dutch-ringed Whimbrels come from coastal regions in western France and West Africa, south to Gabon (Glutz von Blotzheim *et al.* 1977; Ferns *et al.* 1979; Speek and Speek 1984). In spring, some breeding birds from Fennoscandia and the area around the White Sea follow a more easterly route, indicated by recoveries from Italy (Glutz von Blotzheim *et al.* 1977; Dobrynina, in Ilychev 1985). Possibly some birds passing through West Africa reach South Africa. Birds arriving in autumn tend to do so relatively later in Sénégal than in Ghana, probably after having taken a longer route along the coast instead of a direct crossing over the Sahara (Cramp and Simmons 1983). Birds wintering on the coasts of the Gulf of Guinea therefore may have reached their wintering area via two different routes. Birds migrating through East Africa are probably of Siberian origin and certainly include *N. p. alboaxillaris* from the southern Soviet Union.

Summing up numbers in wintering areas along the western European and West African coasts, and including those from the west coast of South Africa, yields a figure of about 69 000 birds, providing a preliminary 1% criterion of 700 birds. Recent estimates of numbers breeding in Iceland (200 000 pairs), Fennoscandia (45 000), the Faeroes (2800), and the Shetlands (400) alone yield 250 000 pairs (Piersma 1986b). This number still excludes those breeding in the western Soviet Union and therefore should be regarded as a minimum estimate for the total population. This figure is equivalent to about 600 000 to 700 000 birds on the wintering grounds. Obviously, there is a large discrepancy, which may be caused by inaccurate estimates of numbers breeding in Iceland (A. Gardarsson, in Piersma 1986b). Another explanation is that information on wintering numbers in the East Atlantic flyway is far from complete. Some birds may be present on as yet uncensused non-estuarine coasts (e.g., Kersten *et al.* 1983), but densities found so far on the Moroccan rocky shores cannot explain the huge difference between estimates from breeding bird surveys and those from counts of the wintering grounds. It is likely that a considerable number of birds are still to be found in coastal habitats not yet surveyed.

Sites regularly supporting 700 Whimbrels or more are shown in Figure 23. There are no complete counts available for Whimbrels in the Democratic Republic of Guinea (site 6 in Fig. 23). Low-water surveys on a limited number of mudflats (Altenburg and van der Kamp 1989) yield a preliminary estimate in the order of 10 000 birds.

7.16. Eurasian Curlew *Numenius arquata*

Curlews breed in boreal, temperate, and steppe regions in Europe and Asia, ranging from Iceland to the central Soviet Union. The wintering area covers most of the Atlantic and Mediterranean coasts, Arabia, the Indian Ocean, and Southeast Asia, although concentrations of wintering Eurasian Curlews can also be found inland, e.g.,

in Ireland (Lack 1986). There are two subspecies. The area in which both subspecies as well as intermediates occur ranges from the eastern part of the Mediterranean to the Indian west coast. In the area of the East Atlantic flyway, both subspecies may be found, the nominate being far more numerous. In central Europe, *orientalis* have become more numerous in the course of this century. There are indications that migration routes of this subspecies now extend farther west than in the early part of this century (Cramp and Simmons 1983). Irish birds are more or less resident. Fennoscandian, Baltic, and northwestern Soviet Union birds winter from Britain and Ireland to western France (Cramp and Simmons 1983), some going farther south to northern Spain and Portugal (Glutz von Blotzheim *et al.* 1977; Saurola 1982). Some German and Dutch birds again go somewhat farther south, some reaching Morocco. Central and southeastern European Eurasian Curlews winter on the Atlantic coast and in the Mediterranean (Schlenker 1982). The origin of birds wintering in Mauritania has not yet been determined (Cramp and Simmons 1983). Eurasian Curlews wintering in Guinea-Bissau have very long bills, corresponding to

measurements from Indonesia, and may represent *N. a. orientalis* (Zwarts 1988). Eurasian Curlews from the Gulf of Guinea south to South Africa consist predominantly of *orientalis* as well, although now and then some *arquata* are present. Birds wintering in the Niger inundation zone and in Sudan probably cross the Sahara and presumably consist of *orientalis* (Cramp and Simmons 1983).

Based on the Eurasian Curlew migration patterns described above, the East Atlantic flyway population has been considered here to include western Europe, the western part of the Mediterranean, and West Africa, south to Sénégal. The size of this population amounts to 348 000 birds (Table 5), yielding a 1% criterion of 3500 birds. Sites holding "internationally important" numbers are shown in Figure 24. Compared with Prater's (1976) review, numbers in Europe have doubled, but this increase is rather difficult to interpret. Numbers in Ireland appear to have increased sharply, but this is mainly due to a more complete picture of wintering numbers. Numbers in estuaries in Great Britain, which had been surveyed well before the end of the 1960s, dropped from 60 000 to 48 000. The total number for Britain, however, has increased again

Figure 23

Wetlands supporting more than 1% (=700) of the Whimbrel population in the East Atlantic flyway: Mauritania: 1 Baie d'Arguin (1800), 2 Banc d'Arguin (17 000); Sénégal: 3 delta Saloum (1000), 4 Casamanche (1000); Guinea-Bissau: 5 Arquipelago dos Bijagos (42 000); 6 Dem. Rep. Guinea (more than 10 000); Sierra Leone: 7 Sierra Leone River (1100), 8 Yawri Bay (2000)

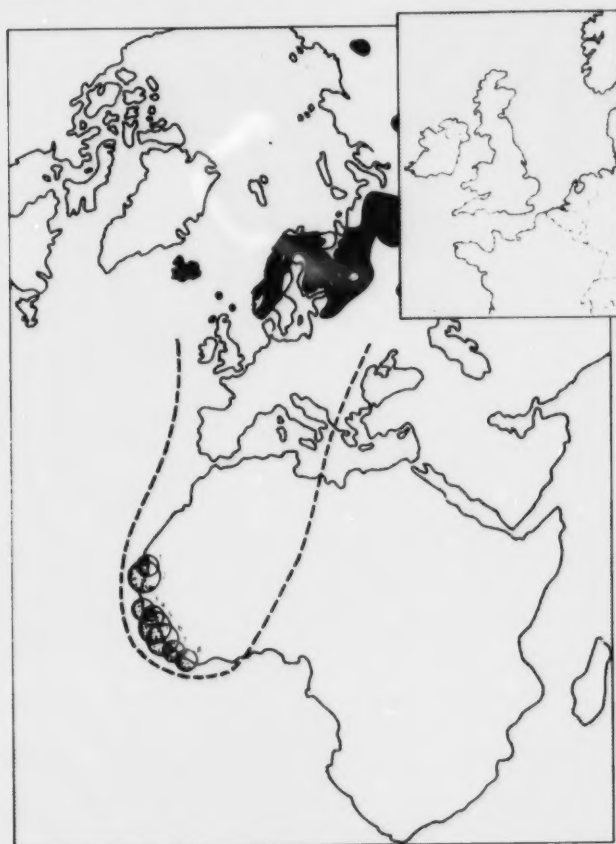
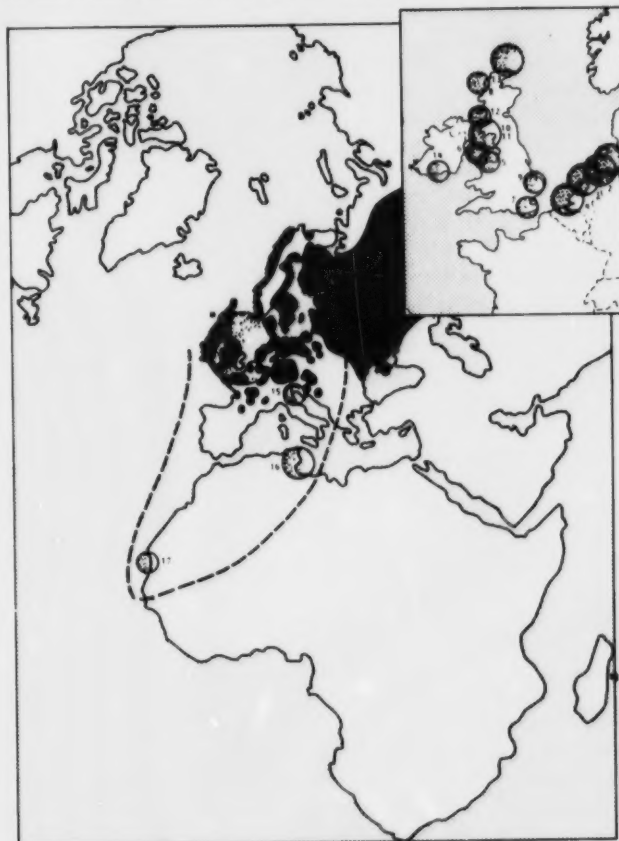


Figure 24

Wetlands supporting more than 1% (=3500) of the Eurasian Curlew population in the East Atlantic flyway. Some wetlands holding numbers slightly below the 1% criterion are also included: Federal Republic of Germany: 1 Wattenmeer Schleswig-Holstein (15 000), 2 Wattenmeer Niedersachsen (25 000); The Netherlands: 3 Waddenzee (50 000), 4 Delta (12 000); United Kingdom: 5 Dee (3200), 6 coast Isle of Man (3200), 7 Thames (3400), 8 Highland coast (3500), 9 Wash (3700), 10 Solway (5200), 11 Morecambe Bay (8600), 12 Strathclyde coast (9800), 13 Orkney coast (18 000); Ireland: 14 Southwest Irish coast (4000); Italy: 15 coast N Adriatic (3700); Tunisia: 16 Gulf of Gabès (11 000); Mauritania: 17 Banc d'Arguin (8000).



because of the incorporation of previously unsurveyed nonestuarine coasts. Numbers in the Wadden Sea have increased, but this may also be a result of more complete data. Clearly, local decreases in Eurasian Curlew numbers have occurred. This appears to be true mainly for the Fennoscandian population and may have been a result of intensive shooting in Denmark and France (Meltote 1986).

The total number of Eurasian Curlews using the East Atlantic flyway will be somewhat larger than calculated above. In some countries, large numbers of Eurasian Curlews winter inland and are rarely included in the counts. The total number of birds involved is not well known. In Ireland, 50 000 birds may be present, and in Britain their number is estimated at 5000 to 7000 (Lack 1986). In mild winters, more than 20 000 may winter inland in The Netherlands (SOVON 1987). These figures have not been included in the calculation of the flyway population.

Adding up the number of breeding pairs for western Europe yields a total of 125 000 pairs (Piersma 1986b). This figure does not include numbers breeding in the Soviet Union and should therefore be regarded as a minimum. Such a population yields 300 000 to 500 000 birds on the wintering grounds, in good agreement with the numbers actually counted.

7.17. Spotted Redshank *Tringa erythropus*

Spotted Redshanks breed in subarctic and arctic habitats in northern Fennoscandia and the Soviet Union. The species is less marine than most of its congeners. In winter, it may be found in a wide variety of habitats: along pools, rivers, lakes, salt pans, and lagoons, and in shallow floodlands, irrigated rice fields, and sewage farms. The wintering area ranges from the West African and Mediterranean coast, through a narrow belt of wetlands in the Sahel and adjacent savanna zone in Africa, to the coasts of the Indian Ocean, the large rivers on the Indian subcontinent, and Southeast Asia. Migration occurs on a broad front, overland and along the western seaboard, leading to local concentrations of some thousands. Such concentrations have been found in the Dollard (German-Dutch Wadden Sea), the Delta area, Hungary, Greece, Turkey, Black Sea, and Caspian Sea (Cramp and Simmons 1983). Ringing recoveries giving clues as to migration routes are limited but do indicate that some birds show a tendency to perform loop migration. Spotted Redshanks wintering in Mali, Nigeria, and Chad arrive there by crossing the Sahara (Cramp and Simmons 1983). Birds wintering in coastal lagoons in Ghana leave their wintering area by overflying the Sahara in a northeasterly direction (Grimes 1974).

Obviously, it is difficult to describe the borders of the East Atlantic flyway for a species wintering inland to such an extent, and also to estimate the number of birds involved. Combining the results of midwinter censuses in coastal wetlands in Europe and Africa yields a total population of 6500 birds, including 2000 in coastal Ghana (Ntiemoa-Baidu and Grieve 1987). The size of the European breeding population alone is estimated at 45 000 pairs (Piersma 1986b), excluding numbers in the Soviet Union. This figure would yield 100 000 to 150 000 birds on the wintering grounds. Because of the small number of birds sufficient to provide "internationally important" numbers and the large discrepancy between this figure and the one based on estimates of the breeding population, no attempts have been made to point out areas specifically important for Spotted Redshanks.

7.18. Redshank *Tringa totanus*

Redshanks breed mainly in temperate and steppe habitats over a wide area, ranging from Iceland through continental Europe and the central Soviet Union to eastern Siberia. Several subspecies are distinguished, two of which are found in the area of the East Atlantic flyway. It is not possible to distinguish these two subspecies in the field. Using biometrical measurements, especially wing length, it is possible to distinguish *T. t. robusta* from the nominate subspecies, although there is some overlap in measurements.

Tringa t. robusta, which breeds in Iceland and in small numbers in the Faeroes, winters in coastal habitats from southern Iceland and southern Norway to Ireland and countries bordering the North Sea, occasionally south to Portugal (Cramp and Simmons 1983). Biometrics indicate that small numbers winter regularly in the Vendée, France (Fournier and Spitz 1969). British and Irish breeding birds, which have been considered to be a subspecies intermediate between *robusta* and *totanus* (Hale 1980), are primarily resident. Some migrate to western France (Fournier and Spitz 1969) and occasionally as far as Portugal (Cramp and Simmons 1983). Fennoscandian and Baltic Redshanks are more migratory and have been found wintering from the North Sea countries through the western part of the Mediterranean to West Africa, some going as far south as the Ivory Coast and Ghana (Cramp and Simmons 1983). Phenology patterns on the Banc d'Arguin (Dick 1975) show that some of the birds wintering on the Gulf of Guinea arrive there by following the West African coast. Some birds, however, apparently cross the Sahara (Cramp and Simmons 1983). Continental birds from northwestern European breeding populations winter from the Channel coast to Sénégal, but most are found around the Bay of Biscay, northwestern Spain, and in Portugal. Western Russian Redshanks are assumed to winter in the eastern Mediterranean, Red Sea, Arabian Gulf, and areas farther south and east, but there are no ringing recoveries to confirm this (Cramp and Simmons 1983).

The migration patterns pictured above led to the distinction of two populations of Redshanks within the area of the East Atlantic flyway, both showing a characteristic migration pattern and both linked to a specific breeding area. There is some overlap in the wintering areas of these populations, mainly in Britain and Ireland (*robusta* and the local breeding population of *totanus*) and northern France (*robusta* and continental European *totanus*). The sizes of these populations are estimated at 109 000 (northwestern European wintering population) and 177 000 (western Europe to Gulf of Guinea), but because of the overlap mentioned and reasons discussed below, we suggest 1500 birds as the 1% criterion for both populations. Sites supporting "internationally important" numbers in northwestern Europe are shown in Figure 25. Numbers in two other wetlands in Sierra Leone (Scarcies estuary and Sherbo River) probably also support "internationally important" numbers, but no complete censuses have been carried out there yet. Numbers present in the Democratic Republic of Guinea probably qualify as "internationally important" as well, but no complete counts have been carried out there so far. Estimates of numbers present on the mudflats during low tide (Altenburg and van der Kamp 1989) yield a preliminary figure of some tens of thousands. These numbers have not yet been included in the population estimate.

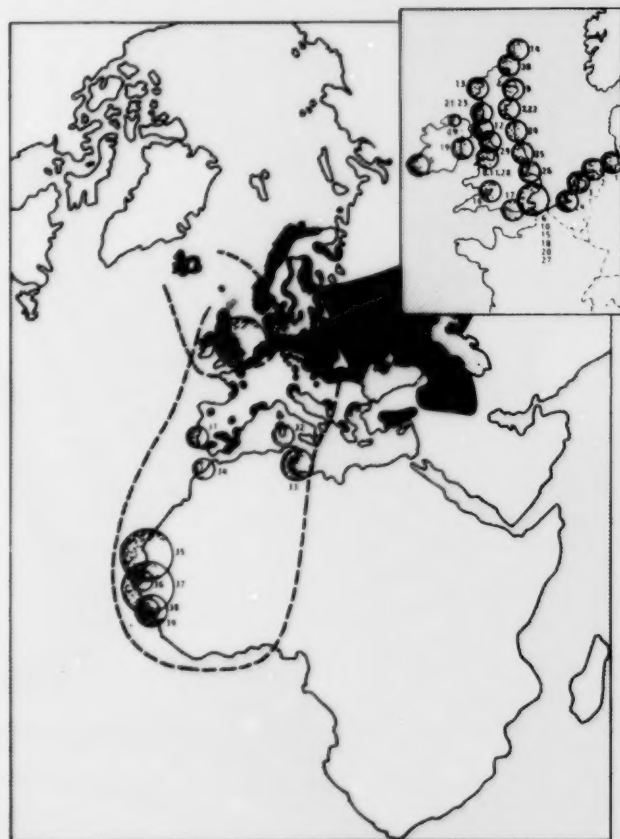
There is still a rather large discrepancy between figures based on breeding bird surveys and those from midwinter wader counts. The Redshank population in northwestern Europe, estimated at 109 000 birds, is composed of both Icelandic *robusta* and British and Irish *totanus*. These breeding populations are now estimated at 100 000 and about 35 000 pairs, respectively, yielding a total wintering population of 300 000 to 400 000 birds. This implies either that the estimates of the breeding populations are too high (which may be true, especially for Iceland; A. Gardarsson, in Piersma 1986b) or that results from midwinter surveys are still incomplete. To a smaller extent, the same applies for the Redshank population wintering in western Europe and West Africa. This population is estimated at 177 000 birds and broadly includes breeding birds from Fennoscandia and continental western and central Europe. The population breeding in this region is estimated at 130 000 pairs, more or less

equivalent to 300 000 to 400 000 birds on the wintering grounds. In this population, more than 100 000 birds are still "missing."

Compared with Prater's (1976) review, numbers in Europe have remained more or less stable. This phenomenon is rather difficult to interpret. Numbers in estuaries in Great Britain have dropped from 80 000 to 54 000, whereas the total figure for Britain has increased as a result of the incorporation of previously unsurveyed nonestuarine habitats. An obvious decrease can be noted in Portugal, and a slight one in France. Numbers in the Wadden Sea have increased, but again this is partly a result of more complete data. As a whole, Redshank numbers in the wintering areas have decreased, possibly as a result of declining breeding bird numbers. Such a decrease has been noted in Belgium, The Netherlands, the Federal Republic of Germany, Denmark, the German Democratic Republic, and, locally, in Great Britain. An increase, however, is noted in Finland (Cramp and Simmons 1983).

Figure 25

Wetlands supporting more than 1% (=1500) of the northeastern European and the western European/West African Redshank population: Federal Republic of Germany: 1 Wattenmeer Schleswig-Holstein (1500), 2 Wattenmeer Niedersachsen (3000); The Netherlands: 3 Waddenzee (9000), 4 Delta (3200); Ireland: 5 Shannon (1500); United Kingdom: 6 Hamford Water (1500), 7 Tay (1500), 8 Mersey (1500), 9 Cromarty Firth (1600), 10 Swale (1600), 11 Alt/Ribble (1900), 12 Solway (2400), 13 Highland coast (1600), 14 Shetland (1800), 15/18 Orwell/Stour (4900), 16 Severn (2100), 17 Langstone/Chichester Harbour (2900), 19 Strangford Lough (2400), 20 Medway (2500), 21 Strathclyde coast (2600), 22 Firth of Forth (2800), 23 Inner Clyde (2800), 24 Lindsfarne (3000), 25 Humber (3400), 26 Wash (3900), 27 Thames (4300), 28 Dee (5000), 29 Morecambe Bay (5600), 30 Orkney coast (6800); Portugal: 31 Tejo (2100); Italy: 32 Stagno di Molentargio (2500); Tunisia: 33 Gulf of Gabès (16 000); Morocco: 34 Merja Zerga (3000); Mauritania: 35 Banc d'Arguin (50 000); Guinea-Bissau: 37 Arquipelago dos Bijagos (83 000); Sierra Leone: 38 Sierra Leone River (4000), 39 Yawri Bay (14 000)



7.19. Common Greenshank *Tringa nebularia*

Common Greenshanks breed in temperate, boreal, and subarctic habitats from Scotland and Fennoscandia to eastern Siberia. During migration and in winter, Common Greenshanks are present in a wide variety of habitat types, on the coast as well as inland. Common Greenshanks may be found on estuaries, muddy or sandy tidal flats, lagoons, mangrove swamps, saltpans, salt marshes, pools on tidal reefs, rivers, lakes, reservoirs, pools, sewage farms, mudbanks, and sandspits.

The wintering area of this monotypic species ranges from the western European and West African Atlantic coasts, through the Mediterranean, inland Africa south of the Sahel zone, and South Asia to Australia. Migration probably occurs on a broad front, with recoveries of birds ringed in northeastern Europe in Morocco, Mali, Sierra Leone, Ghana, the Democratic Republic of Guinea, Nigeria, and Zaire. Recoveries of South African-ringed birds in the European Soviet Union demonstrate that some Common Greenshanks reach wintering areas very far south (Tree 1987). In Africa, wintering Common Greenshanks are found inland and in coastal wetlands. Birds wintering in Britain and Ireland probably originate mainly from the Scottish breeding population (Lack 1986). Fennoscandian birds cross central Europe and the Sahara and have been recovered in Mali and on the coast of the Gulf of Guinea and northern Zaire. Breeding birds from the northwestern part of the Soviet Union show the same migrational pattern as Fennoscandian birds (Cramp and Simmons 1983). Birds captured in South Africa lay down large fat loads, enabling them to reach arctic breeding areas in a limited number of steps (Summers and Waltner 1979).

As with the Spotted Redshank, it is difficult to describe the borders of the East Atlantic flyway for a species wintering inland to such an extent, or to estimate the total numbers wintering. Combining the results of midwinter censuses in coastal wetlands in Europe and Africa yields a total population of 19 000 birds, including birds wintering in Ghana, Namibia, and South Africa. This leads to a preliminary 1% criterion of 200 birds. The size of the European breeding population alone is estimated at 109 000 pairs (Piersma 1986b), excluding numbers in the Soviet Union, where the species is abundant in suitable habitats (Cramp and Simmons 1983). The figure for Fennoscandia alone would produce 250 000 to 300 000 birds on the

wintering grounds. Because of the large gaps in our knowledge, no attempts have been made to point out sites supporting "internationally important" numbers.

7.20. Common Sandpiper *Actitis hypoleucos*

Common Sandpipers breed in a wide band of climatic and vegetation zones from western Europe to East Asia. Their breeding habitat consists of borders of clear lakes, pools, rivers, or streams. Outside the breeding season, Common Sandpipers may be found anywhere where fresh, brackish, or salt water is available, most frequently in freshwater habitats. The wintering area of this monotypic species covers the whole of Africa, south of the Sahel zone, the coast of the Arabian peninsula and the Indian Ocean, most of Southeast Asia, and China and Australia. Migration occurs on broad fronts, usually singly or in small flocks. Especially in autumn, the species may aggregate in favourable places, but large concentrations are rare. Recoveries of Fennoscandian-ringed birds show that the main migration routes have a southwest-northeast direction. Some central European birds have been found to migrate to western Europe first, whereas others have been recovered in the Mediterranean. Birds from Finland, Poland, and Czechoslovakia have been found wintering in Mali, Guinea-Bissau, Sierra Leone, the Ivory Coast, Ghana, and Nigeria, suggesting that birds wintering in Central and South Africa come from more easterly (USSR) populations (Cramp and Simmons 1983).

We have considered birds wintering in Europe, the western part of the Mediterranean, and West Africa, including the whole northern coastline of the Gulf of Guinea, as belonging to the East Atlantic flyway. The size of this population, based on counts in the wintering areas, amounts to 39 000 birds. This figure leads to a preliminary 1% criterion of 400 birds. It is difficult to describe the borders of the East Atlantic flyway for a species wintering inland to such an extent. Also, for this species, there is an extremely large difference between population estimates based on counts in the wintering areas and figures based on breeding bird numbers. The size of the European breeding population alone is estimated at 880 000 pairs (Piersma 1986b), excluding numbers breeding in Estonia (2500; Cramp and Simmons 1983). The species is therefore probably the most numerous wader species breeding in western and central Europe (Piersma 1986b). This estimate yields a population of at least 2 million birds on the wintering grounds. Because of the large gaps in our knowledge, no attempts have been made to point out sites supporting "internationally important" numbers. Common Sandpipers are known to be numerous only in Liberia, where 25 000 to 30 000 of them winter (Gatter 1988), distributed over many habitat types all over the country. Most of the Common Sandpipers that are still "missing" are presumably distributed over numerous African inland wetlands.

7.21. Ruddy Turnstone *Arenaria interpres*

Ruddy Turnstones breed along coasts in boreal, temperate, arctic, and high-arctic climatic zones. The breeding area ranges from Scandinavia, Siberia, and North America to Greenland. Birds from northern Canada belong to the subspecies *morinella*. All others are considered to belong to the nominate subspecies. Wintering Ruddy Turnstones are almost cosmopolitan in coastal marine habitats. Within the breeding area, three populations of

nominate Ruddy Turnstones can be distinguished, all showing migration patterns not yet totally revealed, to some extent also partially overlapping. Birds breeding in northeastern Canada and Greenland winter mainly in northwestern Europe and the Iberian peninsula (Cramp and Simmons 1983), but recoveries in Greenland and Iceland of Mauritanian-ringed birds show that at least some birds winter in areas farther south (Altenburg *et al.* 1982; Ens *et al.* 1989). Fennoscandian and western Russian birds migrate through the Baltic or along the Norwegian coast to winter in Morocco and West Africa. A minority of this population winters in western Europe and the western part of the Mediterranean, but the bulk goes south of 20°N. Ruddy Turnstones breeding from the White Sea to central Siberia probably migrate through the Caspian Sea, Black Sea, and Kazakhstan lakes to winter in the eastern Mediterranean, East Africa, and the coasts of the Red Sea and the Indian Ocean, southward to Cape Province in South Africa. Birds of the latter population sometimes drift westward during autumn migration but return to the breeding areas using a more easterly route (Cramp and Simmons 1983).

Migration patterns pictured above have led to the distinction of two populations of Ruddy Turnstones within the area of the East Atlantic flyway. We have used the Strait of Gibraltar as the demarcation line between their wintering areas. In southwestern Europe and Morocco, there is some overlap in the wintering areas, but numbers wintering in this region are relatively small and will not greatly influence the estimates of population sizes. The European wintering population is estimated at 67 000 birds (Table 3), leading to a 1% criterion of 700 birds. This number is likely to increase as soon as more information becomes available on numbers wintering in Iceland, southern Norway, and Ireland, all coasts where large numbers of Ruddy Turnstones winter. These coasts, however, have been surveyed very incompletely or not at all. Sites that are "internationally important" for wintering Ruddy Turnstones are shown in Figure 26.

Compared with Prater's (1976) review, the European wintering population has increased dramatically (from 12 900 to 67 400 birds). The major reason for this increase has been the incorporation of surveys from nonestuarine coasts in Britain, where 35 000 were recorded (Moser and Summers 1987). Elsewhere, numbers have also gone up slightly, which may partly be due to a real increase in population. The African wintering population is estimated at 31 700 birds (Table 5), leading to a 1% criterion of 300 birds. Sites supporting "internationally important" numbers are shown in Figure 27. Numbers present in the Democratic Republic of Guinea (site 8 in Fig. 27) have not yet been surveyed in detail. Numbers seen on some mudflats surveyed during low tide (Altenburg and van der Kamp 1989) indicate that some thousands also occur there.

8. Inland wader counts

On some occasions, freshwater and coastal habitats are difficult to separate. This applies, for instance, to wetlands bordering the rivers in southern Mauritania and Sénégal. In this paper, the river mouths have been considered to be coastal habitat, whereas areas farther upstream and (to some extent temporary) lakes bordering these have been considered as inland habitats. An exception has been made for some temporary inland brackish lakes in

Algeria and Tunisia. Few numerical data are available on wader numbers inland. The most important reason for this is that inland waders disperse over a large number of frequently small and ephemeral freshwater wetlands. Furthermore, small changes in water levels of inland wetlands often have drastic effects on their suitability for waders. As a result, wader numbers at a specific inland site vary much more than in most coastal habitats.

One of the few areas where reliable extrapolations on inland wintering wader numbers have been made are the rice fields in Guinea-Bissau (Table 9). Information on inland wader numbers in West Africa has been summarized by Ledant *et al.* (1985). Important sites are Lac d'Aleg in Mauritania (with 1000 Black-winged Stilts), the valley of the Sénégal river (5000 Black-tailed Godwits) and Lac de Guier in Sénégal (up to 100 000 Ruffs and 3000 Black-tailed Godwits), and the Gambia River (10 000 Ruffs). By far the most important inland wintering site in West Africa is the inundation zone of the river Niger in Mali. In this huge area, hundreds of thousands of Ruffs, tens of thousands of Little Ringed Plovers, Common Ringed Plovers, Little Stints, and Black-tailed Godwits, and thousands of Black-

Table 9
Extrapolations from wintering wader numbers in five different types of rice fields in Guinea-Bissau (after Altenburg and van der Kamp 1986)

Species	No.
Avocet	50-200
Little Ringed Plover	200-500
Common Ringed Plover	750-1250
Snowy Plover	10-50
Black-bellied Plover	300-500
Little Stint	10 000-20 000
Curlew Sandpiper	3000-5000
Ruff	50 000-75 000
Common Snipe	750-1250
Black-tailed Godwit	110 000-120 000
Bar-tailed Godwit	250-500
Whimbrel	3000-5000
Spotted Redshank	500-1000
Redshank	2000-4000
Marsh Sandpiper	2500-5000
Common Greenshank	2500-5000
Green Sandpiper	100-500
Wood Sandpiper	25 000-50 000
Common Sandpiper	2000-5000
Total	212 910-299 750

Figure 26

Wetlands supporting more than 1% (=700) of the northwestern European Ruddy Turnstone population in the East Atlantic flyway. Some wetlands holding numbers slightly below the 1% criterion are also included: Federal Republic of Germany: 1 Wattenmeer Schleswig-Holstein (800); The Netherlands: 2 Waddenzee (2500), 3 Beach North Sea coast (600), 4 Delta (2600); Belgium: 5 Beach North Sea coast (600); Faeroes 6 (1400); United Kingdom: 7 Belfast Lough (1100), 8 Down coast (2000), 9 Burry Inlet (600), 10 Cornwall coast (600), 11 N Yorkshire coast (600), 12 Guernsey (700), 13 Thames (700), 14 Fife coast (700), 15 Kent coast (700), 16 Wash (800), 17 Scilly Isles (900), 18 Tiree (1000), 19 Gwynedd coast (1000), 20 Firth of Forth (1100), 21 Morecambe Bay (1300), 22 Northumberland coast (1300), 23 Lothian coast (1300), 24 Lewis/Harris (1400), 26 Highland coast (2200), 27 Uists (2600), 28 Grampian coast (2800), 29 Strathclyde coast (3200), 30 Shetlands (5100), 31 Orkney (6000); France: 32 Bretagne N coast (2100), 33 Bretagne S coast (900).

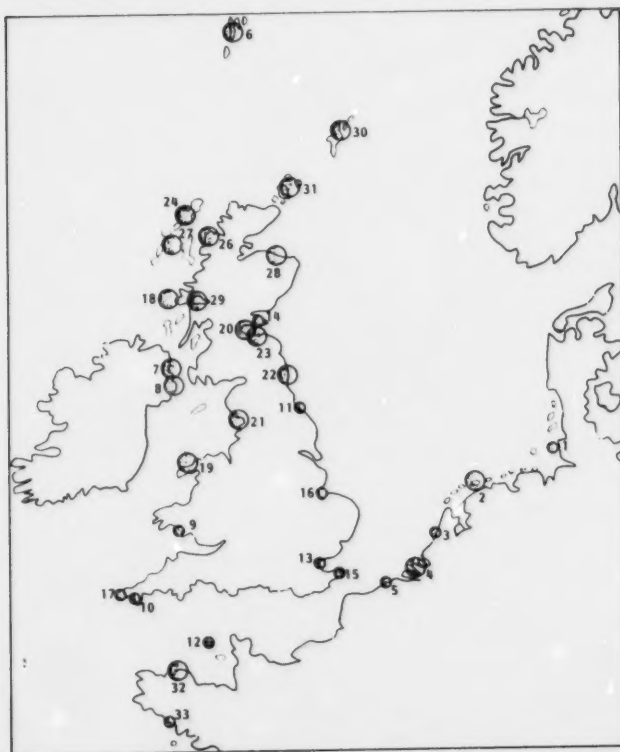
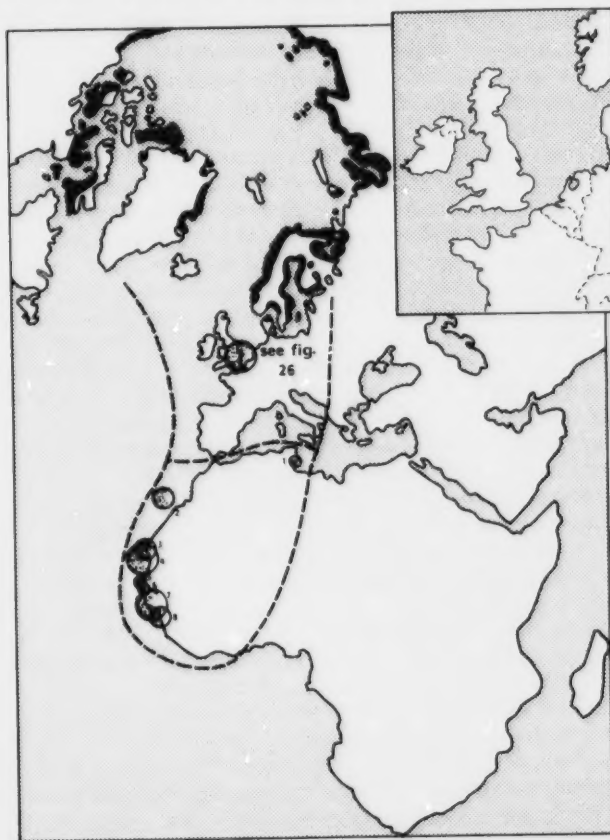


Figure 27

Wetlands supporting more than 1% (=300) of the West African Ruddy Turnstone population in the East Atlantic flyway: Tunisia: 1 Gulf of Gabès (400); Spain: 2 Canary Islands (1800); Mauritania: 3 Presqu'île de Cap Blanc (1000), 4 Banc d'Arguin (11 000); Sénégal: 5 Delta Saloum (800); Gambia: 6 Gambia River (400); Guinea-Bissau: 7 Arquipélago dos Bijagos (15 000)



winged Stilts, Collared Pratincoles *Glareola pratincola*, Common Snipes, Common Greenshanks, and Spotted Redshanks may winter. Complete simultaneous counts or aerial censuses of waders have not yet been possible. The data from freshwater counts obviously show a different species composition compared with the coastal censuses. Ruff, Black-tailed Godwit, Little Stint, and several *Tringa* species dominate the freshwater species spectrum. An estimate for the total number of waders wintering inland is still impossible to give but will be in the order of several million. This means that the total number of waders, from coastal as well as freshwater habitats, using the East Atlantic flyway may be in the order of 10 million.

From data in Price *et al.* (1986) and Summers *et al.* (1987a), we can make a rough estimate in the order of 5 to 6 million wintering waders for the entire East African/Arabian flyway. The most important inland area is the pools and flooded grasslands of the Sudd in Sudan, where hundreds of thousands of Little Stints, Ruffs, Common Snipes, and Wood Sandpipers are present until January. The waders using Lake Chad (1 million Ruffs within a 25-km radius around the mouth of the Yobe River in March–April 1967; Ash *et al.* 1967) and those wintering in Egypt have been excluded from the estimate for the total numbers using the East African/Arabian flyway. Those areas have been considered to be part of the Mediterranean flyway. Numbers using the latter flyway are even less well known, and information on waders wintering in Central Africa is largely lacking. We know only that in the Congo basin the most frequently encountered wader is the Common Sandpiper, occurring “from sea level up to 6000 feet along the banks of almost every river” and “around any lake or open marshy spot, usually in small numbers, often singly” (Chapin 1939).

On the basis of data given by Tye (1987), we may estimate the number for the Atlantic African coast from Ghana to Angola at 250 000. Meininger (in Summers *et al.* 1987a) estimated wader numbers in coastal and inland Egypt at approximately 300 000. Putting the figure for Lake Chad at 1 million, we arrive at a total wintering population for the Mediterranean flyway of at least 1.5 million birds. This figure does not include data for the Black Sea and the Russian part of the Caspian Sea, as data from those areas are still not available. The total number of waders wintering in the whole area of the three flyways described here can therefore be estimated to be in the order of 15 to 20 million. The major unknown factors that could affect this figure are the still unreliable estimates for the numbers present in the Niger inundation zone in Mali, in Sudan, and around Lake Chad. The numbers of waders occurring solitarily or in small flocks along rivers, small pools, and marshes are also important but unknown.

9. Added importance of sites during migration

9.1. Moulting

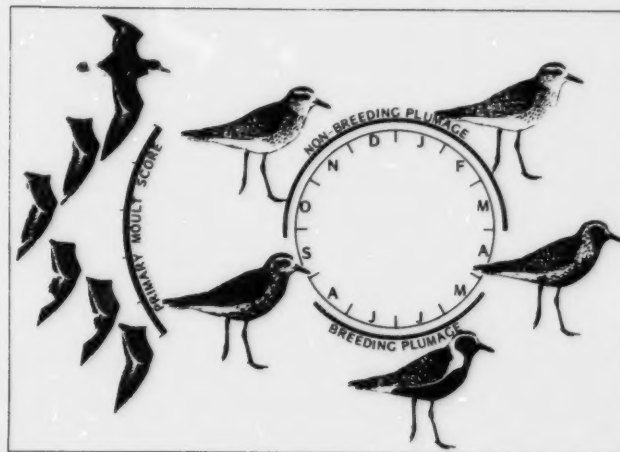
Moult is the process of replacing worn plumage. Wing moult is the most conspicuous type of active moult, often being visible in waders flying overhead (Fig. 28). The active moult of body feathers is not visible if the bird is not in the hand, but the effects of moult may show up as changes in plumage colouration (Fig. 28). The various feather tracts are moulted at different frequencies and at different times of the year. The usual pattern in adult waders (Fig. 28) is for the body plumage to be completely

replaced after the breeding season (the change from breeding to nonbreeding plumage), with part of the belly, breast, and head feathers, and the wing coverts being renewed in spring (the change from nonbreeding to breeding plumage). As a rule, the flight (wing and tail) feathers are moulted only once, sometime after the breeding season.

Moult, and especially the moult of the flight feathers, was considered by many authors to be an energetically costly process (Hanson 1962; Payne 1972; Boere 1976; Murton and Westwood 1977). Recent studies have shown, however, that it is likely that the costs of growing new feathers depend on the species' diet (Masman *et al.* 1986), vegetarian birds incurring much higher costs than carnivorous birds. Because waders feed on a variety of invertebrate animals, the costs of feather synthesis during moult may actually not add much to their required daily intake.

Nevertheless, there are other auxiliary costs to the process of moult. Moulting the body feathers leads to decreased insulation (Masman *et al.* 1986) and hence to increased costs of thermoregulation below certain air temperatures (the so-called Lower Critical Temperature:

Figure 28 Seasonal changes in the appearance of adult male Black-bellied Plovers (right), and the timing and process of wing moult (illustrated at left). The bird drawings are modified after Hayman *et al.* (1986). Moulting schedules are compiled from data in Boere (1976) and Branson (1987).



approx. 22°C for small waders, such as Ruddy Turnstones, down to approx. 10°C for large waders, such as Oystercatchers; Kersten and Piersma 1987). During the replacement of the flight feathers, the wing is incomplete, leading to increased wing loading and flapping frequencies (Sach 1968) and hence to increased energy costs of flight (Masman and Klaassen 1987). Incomplete wings may also lead to a decreased manoeuvrability in the air (Boere 1976) and so to increased risks of raptorial predation.

There are thus several good reasons to consider the periods of moult, and especially the period of wing moult, as critical times in the annual cycle of waders. It is therefore likely that, during moult, waders have special habitat (feeding and roosting site) requirements.

Although the complete body moult, and the wing moult, always start sometime after the breeding season (i.e., in the northern autumn), coastal wader species show considerable variability in the exact timing of wing moult and the locations of moulting sites (Table 10). A comprehensive discussion of the variation in wing moult is provided by Prater (1981b).

Whereas different subspecies may moult at different sites along the East Atlantic flyway, in some species even individuals may use more than one site during one moult of their flight feathers (Table 10). Active wing moult probably interferes with flying large distances (although some waders do migrate in active wing moult; see Pienkowski *et al.* 1976 and Holmgren 1987), and therefore such individuals temporarily interrupt (suspend) their wing moult. After a migratory flight, and perhaps a fattening period at a relatively unfavourable location, moult is resumed elsewhere. Usually moult is suspended for less than two months. By moulting in separate steps, these waders may be able to use good (and sometimes temporary) food resources at locations that are spread out along the migratory route.

At southern moulting sites, wing moult takes place later in the year than at the northern sites, and moult tends to be spread over a longer period (Fig. 29). Waders coming from the (sub)arctic breeding grounds arrive first in the northern coastal wetlands. In addition, the better climatic conditions (and food resources?) at the southernmost locations provide favourable circumstances for moult during a larger part of the year. Immature (nonbreeding) birds, which have spent the northern summer on the wintering grounds, usually start their wing moult several weeks ahead of the adults. It has long been realized that the distribution of waders in the period of wing moult (August–September) is very different from the distribution of waders in winter (e.g., Prater 1981b; Pienkowski and Evans 1984). As shown in Figure 29, moulting coastal waders are concentrated in the largest tidal areas in western Europe and West Africa. The international Wadden Sea and the Banc d'Arguin in Mauritania, each supporting well over a million (and probably over 2 million) waders during moult, are the most important moulting areas. The large estuaries of western and eastern Great Britain, the Dutch Delta, and the coastal wetlands in Tunisia and Guinea-Bissau are also very important, each supporting at least 100 000 moulting waders. Even within the large European estuaries, moulting waders are not distributed in the same way as during winter. According to Prater (1981b): "Very large concentrations occur on the more inaccessible mudflats where there are extensive saltmarshes." The special importance of the largest coastal wetlands may to a

large extent be because they provide both undisturbed area and sufficient food.

9.2. Preparing for flights to faraway destinations: differential importance of sites along migratory pathways

Flying is an energetically expensive activity: its cost is seven to 10 times that of sleeping under "thermoneutral" conditions (Masman and Klaassen 1987). To fuel flights between successive sites along a migration route, waders store large amounts of fat and protein before departure, sometimes almost doubling their body mass (e.g., Davidson 1984). Recent studies on body composition changes in waders before long-distance flights show that 50–60% of the weight increase is due to the deposition of fat. The remaining 40–50% is attributable to increases in the mass of (muscle) protein (Davidson and Evans 1986; van Brederode and Piersma 1989; Piersma and Jukema 1989).

Increases in body mass necessitate increases in the daily amount of ingested food. At some sites, food, or the density of competing conspecifics, may limit the possible daily weight increase (Piersma 1987). If the first suitable site after departure is attainable only after a long-distance flight, the period of premigratory "fattening" must in such circumstances be extended. If, during the actual flight to a site, winds are favourable, flight time and therefore flight cost can be much reduced (Piersma 1987). For this reason, it is likely that, during migration, waders always try to choose the heights at which they can profit most from tailwinds (Richardson 1979). If only headwinds are encountered, migration may temporarily be suspended (if a suitable landing site is nearby), or the next stopover site may not be reached. In the latter case, a period of premigratory "fattening" at a suboptimal site may be required.

Waders show an amazing variety of strategies to cover the distances between breeding and wintering grounds (Burger and Olla 1984). Figure 30 portrays three possible travel schemes for waders returning from the important wintering area of Banc d'Arguin, in Mauritania, to the northern breeding grounds in spring. "Hoppers" cover the distance in a series of short flights, using many stopover sites, "skippers" are intermediate, and "jumpers" travel from wintering to breeding areas in a few long flights, using few stopover sites. As shown in Figure 31, making a series of short flights (hop) is always energetically cheaper than covering the same distance in one or two long flights (jump). This is because there are added costs of transporting the extra fuel (i.e., fat and some protein). For birds that are able to use many different stopover sites, the temporary unavailability of one such site is less dramatic than for a "jumper," as "hoppers" can fairly easily move to the next suitable site. Also, because the average rate of weight increase is less for a hopper than for a jumper, there are smaller risks of delays caused by limitations on weight gain in hoppers. In addition, because the flights are so much shorter, there is less chance that adverse wind conditions during the flights will disturb travel schedules. The only extra problem for hoppers may be that they have to find themselves good feeding sites at each successive stopover area, and this may take some time (Alerstam and Lindström 1989).

"Jumping" is therefore not only a costly but also a "risky" strategy, in the sense that adverse feeding conditions at the stopover sites or unfavourable winds en route

Table 10

Characteristics of the wing moult of adults of the coastal wader species using the East Atlantic flyway (compiled from data in Dick 1975; Boere 1976; Cramp and Simmons 1983; Ginn and Melville 1983; Pienkowski and Evans 1984)

Species/subspecies	Occurrence of suspended moult ^a	Timing	Main moulting area(s)
Oystercatcher	No	Late July–September	W Europe
Avocet	No	July–early October	W Europe
Common Ringed Plover	Yes, arctic breeders may start on breeding grounds	Late July–October	W Europe and W Africa
Snowy Plover	Yes	July–September	?
Black-bellied Plover	Yes, common	August–November	W Europe and W Africa
Knot			
<i>C. canutus canutus</i>	No	August–November	W Africa
<i>C. canutus islandica</i>	No	August–October	W Europe
Sanderling	No	August–October	W Europe and W Africa
Little Stint	Yes, common	Late September–January (some resume moult in March)	W Africa
Curlew Sandpiper	Yes, uncommon	September–November	W Africa
Dunlin			
<i>C. alpina alpina</i>	Yes	July–October	W Europe
<i>C. alpina schinzii</i> (Baltic)	No?	July–September	W Europe
<i>C. alpina schinzii</i> (Iceland)	No	August–November	W Africa
<i>C. alpina arctica</i>	No	August–November	W Africa
Bar-tailed Godwit	No	August–early November	W Europe and W Africa
Curlew	No	Late June–October	W Europe
Redshank			
<i>Tringa totanus islandica</i>	No	July–October	W Europe
<i>Tringa totanus totanus</i>	Yes, common	July–October	W Europe and W Africa
Common Greenshank	Yes, common	Late July–November	W Africa?
Ruddy Turnstone	No	August–November	W Europe and W Africa

^aNote that suspended moult is recorded in almost all species: "No" means therefore that it is rare (<2% of adults showing it).

Figure 29

Latitudinal variation in the occurrence of wing moult in adult coastal waders, and the distribution of important moulting sites. Small dot: important site (>100 000); large dot: very important site (>1 000 000 moulting waders: Wadden Sea, Banc d'Arguin). Information on the timing of moult is from Morrison (1976), Boere (1976), Pienkowski et al. (1976), Dick (1975), Wymenga (pers. commun.), Dean (1977), Prater (1981b), and Walther and Sinclair (1981). Information on distribution is from Prater (1981b) and IWRB Wader Research Group archives.

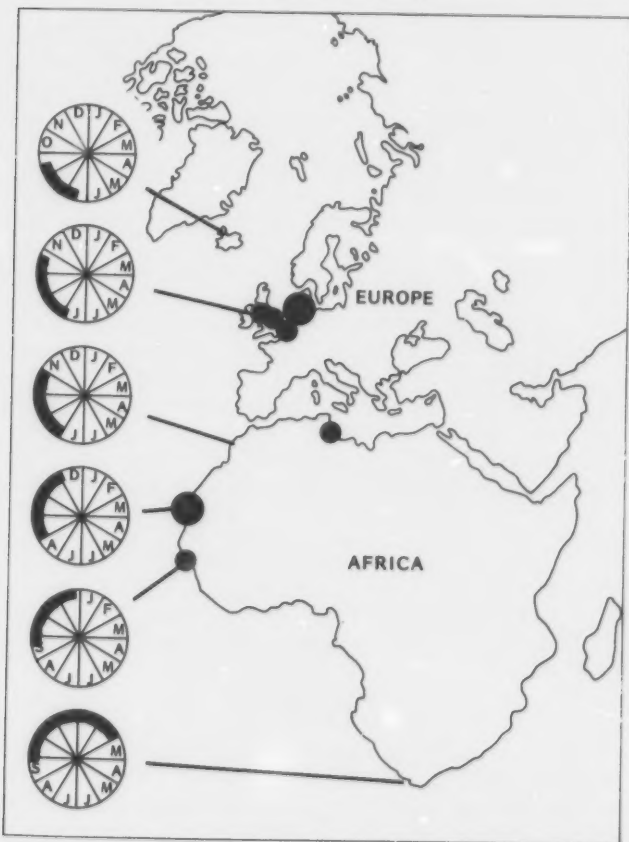


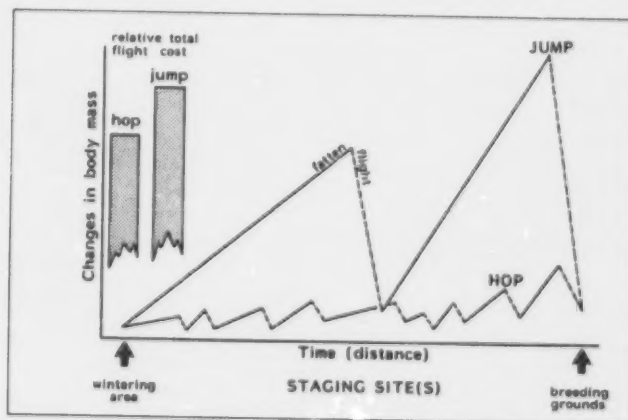
Figure 30

Three alternative travel schemes of waders flying from the West African wintering grounds to their breeding destinations in spring: hop (e.g., early migrating Ruddy Turnstones); skip (e.g., early migrating Dunlins, Redshanks); or jump (e.g., Knots, Bar-tailed Godwits) (from Piersma 1987)



Figure 31

Body mass changes during a migratory episode for waders using the two extreme travel schemes — hop or jump (Fig. 30) — and the total flight costs compared (vertical bars; after Piersma 1987). Note that making a few long flights costs more energy because of the extra costs for transporting the additional fat and protein. Note also that the higher flight costs lead to a steeper average slope of body mass increase in "jumpers."



are likely to lead to later than optimal arrival times on the breeding grounds. The reason that many waders nevertheless make very long flights is thought to be due to a limited availability of high-quality feeding (stopover) habitats along their flyways (Piersma 1987) and, in some cases, the need to cross large bodies of water or ice (e.g., when flying from North to South America, from the Asian continent to Australia, or from Iceland to Europe; cf. Alerstam *et al.* 1986).

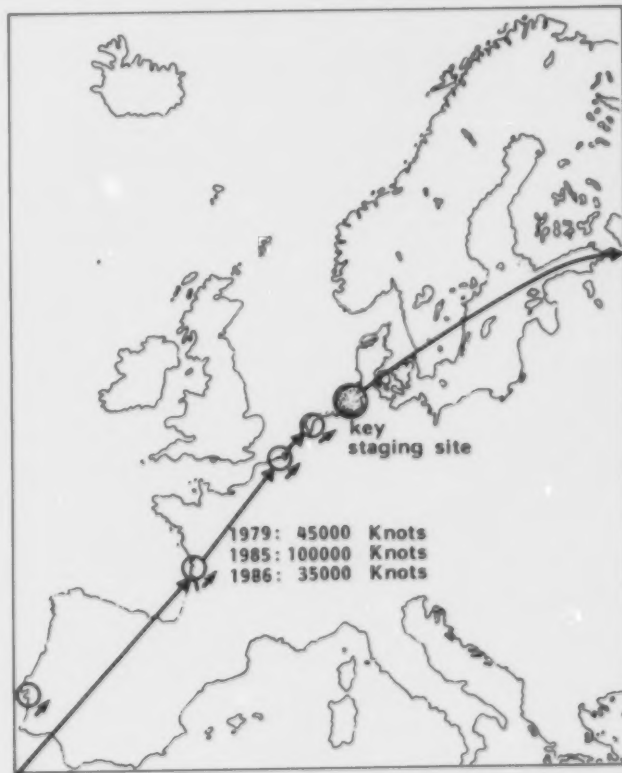
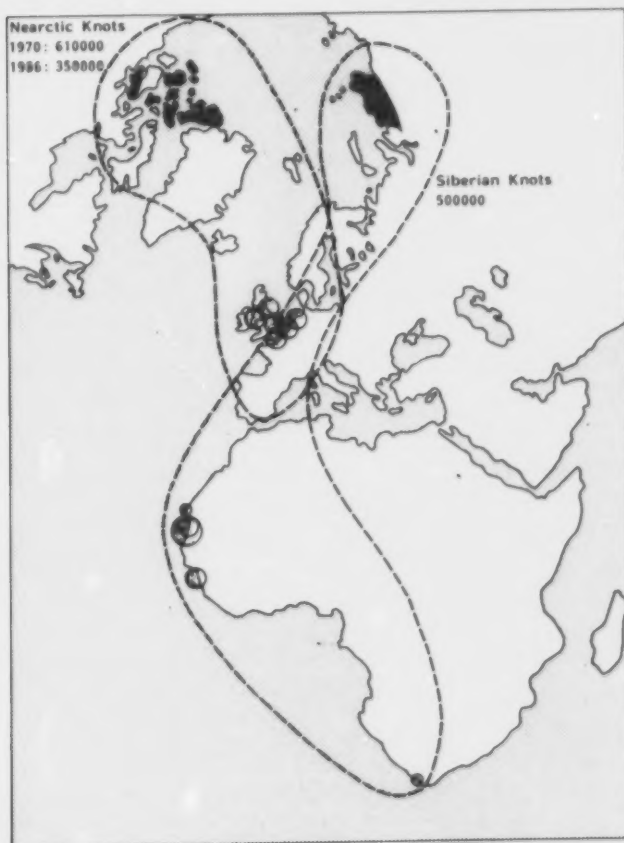
Of course, the precise distinctions between "hoppers," "skippers," and "jumpers" are arbitrary and mainly of heuristic value. However, the existence of different migration schemes (strategies) has important implications for evaluating the importance of different wetlands along a migratory trajectory for a certain species. One implication is that the last stopover site before the breeding area is the most "crucial" in the sense that delays in fattening or timing can still be overcome there. This is possible by speeding up the fattening rate, allowing the bird to depart on time and to arrive on the breeding site in good body condition (Davidson and Evans 1989). It is still unknown whether the "last-site effect" holds for the return

to the wintering grounds as well, but in general it is clear that the fewer stopover sites a species uses, the stronger an eventual "last-site effect" will be (Piersma 1987).

A second implication is that sites that are important for jumpers have added conservation value. A third implication is that because jumpers are susceptible to adverse conditions, both during their long flights and on the staging areas, they may sometimes have to rely on "emergency" sites. Emergency sites are areas where under "normal" (average) circumstances few birds show up during the migrations, but sometimes, when adverse conditions force them to do so, they stage in great numbers. The phenomenon can be illustrated by the example of the Siberian Knot, a typical jumper. Siberian Knots seem to use the intertidal areas of, for example, west-central France in large numbers only during springs when wind conditions between West Africa and western Europe are particularly unfavourable (Fig. 32; Piersma *et al.* 1987b, and unpubl. data). Although this is not clear from a listing of the average counted numbers, in some years the intertidal areas of west-central France are of crucial importance for the greater part of the population of Siberian Knots.

Figure 32

The migration system of the two populations (subspecies) of Knots (Nearctic Knots *Calidris canutus islandica* and Siberian Knots *C. c. canutus*) within the East Atlantic flyway system (left) and the role of some western European sites as emergency stopover sites for Siberian Knots (right). Information was compiled from Dick *et al.* (1976, 1987), Davidson *et al.* (1986), and Piersma *et al.* (1987b, and unpubl. data).



10. Turnover

The evaluation of the relative international conservation importance of coastal wetlands has generally been made through the examination of counts carried out at regular intervals. However, such counts give a true measure of the usage of wetlands only if population turnover between counts is small. That may be fairly true in midwinter, which is the main reason why the results of midwinter counts are used to estimate total population sizes, but it is definitely not the case in spring and autumn. During the passage periods, population turnover of waders may be rapid, especially at wetlands located between the wintering and the breeding areas. The existence of turnover means that many more individual waders may use a wetland than is indicated by the average or even peak number found during a series of counts.

Because it should be our aim to evaluate the importance of a wetland based on knowledge of the proportion of birds of a certain population using the particular site in different phases of its annual cycle, the measurement of population turnover presents a major methodological challenge. In view of the difficulties of measuring turnover, especially at larger coastal sites, few such studies have yet been carried out. A simple method to get a minimum estimate of the number of individual birds is to count the birds very regularly (e.g., once every 3-5 days). Assuming that the differences between the counted numbers are due only to birds moving in and out of the site, the differences between counted numbers can be summed to give a minimum figure for the usage of the site by individual birds. A better estimate of turnover can be obtained by colour-marking a sample of birds in a population and then following their fate (i.e., whether they stay or leave) by regularly scan-sampling the birds present (e.g., Moser and Carrier 1983). With good catches, regular population counts, and colour-mark scans, it is possible to come up with quite accurate estimates of population turnover. In addition, estimates of the average staging times of individual birds can be obtained (Kersten and Smit 1984). The methodology of such turnover studies is discussed in detail by Kersten and Piersma (1983) and Kersten and Smit (1984).

Population turnover studies of waders using staging sites in spring have yielded the following results. Moser and Carrier (1983) were able to show that the number of individual Common Ringed Plovers using the Solway Firth in spring 1983 was at least twice the number recorded during peak counts. At the same time, the numbers of Ruddy Turnstones using the site were barely in excess of peak counts. Kersten and Smit (1984) found that the numbers of individual Common Ringed Plovers, Redshanks, and Dunlins using the small Sidi Moussa estuary in Morocco in March 1981 were on average 1.5 times the number present on 1 March. The calculated average staging times were 6.3 days for Common Ringed Plover, 8.5 days for Redshank, and 12.2 days for Dunlin. These studies were extended in spring 1982, and Figure 33 gives a summary of the results for the Dunlin (Kersten *et al.*, unpubl. data). Although the counts gave a peak of 7000 Dunlins, the turnover studies show that during the entire spring migration period at least three times this number, or 21 000 Dunlins, must have used the site. Using the last figure, the Sidi Moussa estuary certainly qualifies as a site of international importance for Dunlins (the current criterion is 14 000 birds), which was not clear from an

examination of the counts only. Even shorter staging times and consequently higher turnover rates are reported for Little Stints migrating in spring through the Porto Lagos area, a wetland in northeastern Greece. Spiekman (1989), who counted a maximum of 3000 birds, estimated an average length of stay of 3.5 days, which meant that at least 24 000 Little Stints used the Porto Lagos area in the spring of 1986.

11. Discussion

11.1. Changes in apparent population size since Prater (1976)

A comparison of the previous population estimates for wintering waders (Prater 1976) with data presented in this review shows dramatic differences for the African wintering quarters. These differences are mainly due to more complete counts (Morocco, Mauritania) and to the discovery and assessment of new sites (Guinea-Bissau, Sierra Leone, Liberia). It is much more interesting to compare the European data, because for many European coastal wetlands detailed data were already available by the mid-1970s.

Table 11 shows the results of this comparison for the most numerous species. Numbers of Oystercatchers, Common Ringed Plovers, Black-bellied Plovers, Ruddy Turnstones, Purple Sandpipers, Sanderlings, Bar-tailed Godwits, Eurasian Curlews, and Avocets have gone up, whereas numbers of Knots, Dunlins, and Redshanks have gone down. The total figures in Prater's (1976) and the present review differ by about 370 000, an increase of about 13%. There are two potential reasons for such an increase.

Figure 33

Changes in the total numbers of Dunlins at any one time in a Moroccan coastal wetland (Sidi Moussa estuary, 150 km south of Casablanca), and the cumulative number of Dunlins having used this site in the springs of 1981 and 1982 from 1 March to late April. The measurements (counts, catches to colour-mark birds, and scan samples to estimate the number of marked birds still present), which give an estimate for the cumulative number, also lead to an estimate of the turnover rate during a whole spring migration season (late February to mid-May). This figure is compiled from data in Kersten and Piersma (1984), Kersten and Smit (1984), and Kersten (unpubl. data).

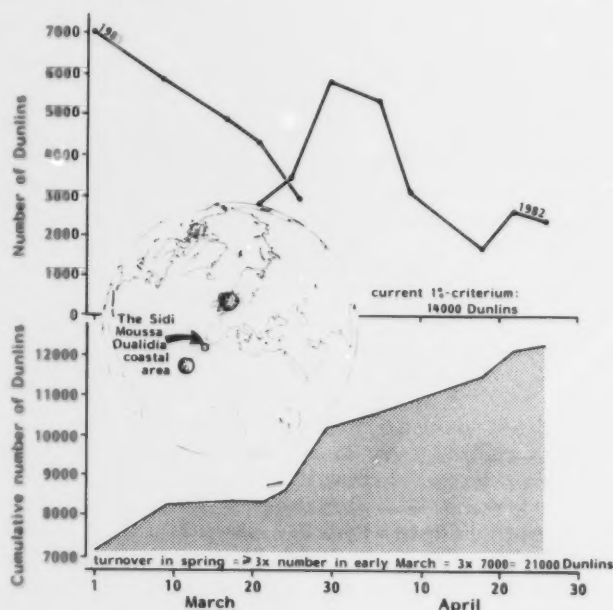


Table 11
Changes in wader population sizes in midwinter along the European Atlantic coast, from Prater (1976) and this review, and the most important reasons behind these changes

Species	Prater 1976	This paper	Reasons for change
Oystercatcher	559 000	856 000	Population increase, more complete coverage
Avocet	18 300	34 500	More complete coverage?
Common Ringed Plover	19 800	42 500	Population increase, more complete coverage
Snowy Plover	<50	5100	More complete coverage
Black-bellied Plover	29 200	61 200	Population increase
Knot	609 300	345 300	Population decline
Sanderling	10 000	26 600	More complete coverage
Purple Sandpiper	?	32 400	More complete coverage
Dunlin	1 180 000	1 135 000	Population decline
Black-tailed Godwit	40 100	45 500	?
Bar-tailed Godwit	89 200	114 900	Population increase, more complete coverage
Eurasian Curlew	145 900	314 700	Increase in coverage
Redshank	123 900	121 600	Population decline
Ruddy Turnstone	12 900	67 400	Increase in coverage
Total (all species)	2 840 000	3 208 000	

First, numbers may actually have gone up. Secondly, more complete coverage has been achieved. No doubt the latter has been the case. Surveys in nonestuarine habitats in Britain alone have yielded 240 000 waders (Moser 1987). Elsewhere in Europe, counts have become more complete as well. This applies especially for Ireland, France, Spain, and Portugal, but to some extent also for the Wadden Sea and the Delta. Real population changes can best be documented using index values, as has been done in the Birds of Estuaries Enquiry, the wader monitoring program of the BTO/NCC/RSPB (Prŷs-Jones and Kirby 1987). In calculating these indices, only those sites that have been surveyed in consecutive years are included. Results therefore cannot be affected by changes in sites covered between years.

Real population changes can be noted for Oystercatchers, for which an increase in wintering numbers is obvious in Britain (Fig. 34). Large numbers of Oystercatchers also appear to be present in previously uncensused areas, such as the nonestuarine coast in Britain, the Wadden Sea in Niedersachsen, and probably elsewhere. Higher breeding population figures have been found in The Netherlands (see Section 7.1.), where numbers increased from 43 000 to 50 000 pairs in 1972-77 (Teixeira 1979) to 90 000 by the mid-1980s (Piersma 1986b).

There has also been an increase in Black-bellied Plover numbers. Historical figures from Great Britain show that this increase started in the 1930s and has continued over the last 15 years (Fig. 34). During the latter period, increases have been noted in only some of the British estuaries, especially those supporting rather small numbers in the past (Moser 1988). As for the Oystercatcher, the population increase of Black-bellied Plovers seems to be linked to an actual increase in population size.

Knot numbers in Europe show a drastic decline, especially in France: Prater's estimate was 110 000, whereas the recent one is 16 000. Numbers in the Baie Mont St. Michel were 40 000 in 1965-69, whereas in January 1987 only 5180 were counted. Over the same period, numbers decreased from 2000 to 150 in the Golfe du Morbihan, and in the Baie de l'Aiguillon from 25 000 to 5650 (Mahéo, *in litt.*). Numbers in Britain have also gone down, which can be demonstrated through the index values (Fig. 34). A series of bad breeding seasons may have contributed to this decline (cf. Section 7.7.).

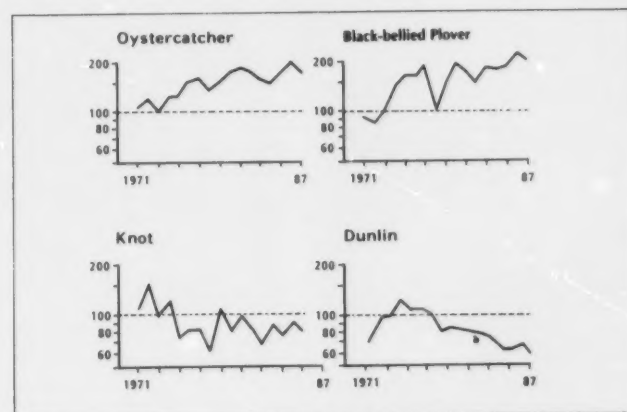
A decrease in Dunlin is noted mainly in Britain and France. Elsewhere, numbers have remained stable or have gone up somewhat, possibly as a result of more complete coverage. The decrease in Britain seems to be explained mainly by the spread of cord grass *Spartina anglica* (cf. Section 11.3.).

As a result of changes in wader population sizes, the 1% criteria may need to be changed as well. In the case of a population increase, this implies that the "international value" of many sites may decrease. Fewer sites will meet the higher international standards. For species wintering in previously uncensused areas in Africa, it would be unrealistic not to take the higher figures into account. The same holds true for northwestern European sites harbouring these birds in spring. When quantifying the value of a northwestern European wetland as a wintering site, the opposite would be true: in this case, it would be unrealistic to take the African winter figures into account, because these birds will never winter in a northwestern European site. For some species, it is not difficult to distinguish European from African wintering populations. For others, different populations cannot be separated easily or mix together in the wintering areas. In the species descriptions (Sections 7.1.-7.21.), a separation into subpopulations or subspecies has been made wherever possible to cope with this problem. Only in this way can the differences in site use by various populations in the East Atlantic flyway be made apparent. If different populations do mix in autumn or spring staging areas, this fact should be acknowledged by applying a combination of 1% criteria of both populations.

11.2. Are the wintering areas "full"?

Ever since coastal wetlands and waders began to be a focus for the attention of scientists and nature conservationists, the question as to whether the intertidal feeding areas used by waders are "full" has been a subject of intensive research and discussion (e.g., Evans 1976; Zwarts 1977, 1984; Goss-Custard 1977, 1978/79, 1980, 1985; Zwarts and Drent 1981; Evans and Dugan 1984; Zwarts and Wanink 1984). A "full" wetland can be defined as an area where the addition of birds would reduce the chances of survival and/or reproduction of those already present. The question is a

Figure 34
Index values for four wader species wintering on the British Isles, based upon counts in wetlands counted in subsequent years (data from Prŷs-Jones and Kirby 1987)



very complicated one, however, as the processes of regulation of numbers work over large temporal and spatial scales. This means that the effects of, for example, local reductions in available food stocks or feeding area are rarely directly visible (cf. Lambeck *et al.* 1987; Goss-Custard and Moser 1988; and below). Wader numbers may be limited on the breeding grounds, on the wintering grounds, and/or on the staging areas used during the migrations (e.g., Goss-Custard 1978/79). Regulation may take place simultaneously in different phases of the annual cycle (Fretwell 1972) and may affect different parts of the population (e.g., sex or age groups) differently via changes in mortality or reproduction. It falls outside the scope of this paper to review in detail the state of affairs in this field of research (for a recent summary, see Goss-Custard 1985).

In spite of the many complications involved in showing that wetlands have reached "carrying capacity," most scientists concerned seem to agree that it is very likely that reductions in the present area of mudflats along the East Atlantic flyway will result in reductions in the number of waders that are dependent on these wetlands (Goss-Custard 1977, 1978/79, 1980, 1983, 1985; Zwarts 1984).

One of the most convincing cases showing that coastal wader populations in western Europe are indeed limited by feeding area comes from a recent analysis by Goss-Custard and Moser (1988) of the changing numbers of Dunlins wintering in Britain. They documented that the number of Dunlins in Britain showed a continuous decrease between 1971-72 and 1985-86, a decrease that up to 1977-78 also occurred in other European wintering areas but then stopped. Dunlin numbers declined at the greatest rates in those areas where cord grass spread over the intertidal flats. On the vegetated mudflat areas, the birds were no longer able to feed. The data suggest that most displaced Dunlins were unable to reestablish themselves elsewhere. Apart from showing convincingly the effects of loss of feeding habitat on population size, the study also indicates the potentially powerful use that can be made of large series of counts.

11.3. Human site use and the limited knowledge of inland waders in Africa

We have acknowledged above (Section 8.) that as yet little is known about the numbers and distribution of waders wintering in inland West Africa and about their ecology (cf. Altenburg and van der Kamp 1985, 1986; Altenburg *et al.* 1986; Jarry *et al.* 1987). This is unfortunate, because human pressures on wetland ecosystems are particularly intensive on the floodplains of Africa (e.g., Gerster 1975; Welcomme 1979; Gallais 1984; Drijver and Marchand 1985; IUCN 1986a, 1986b; Dugan 1987; OAG Münster *et al.*, unpubl. data). Seasonal cattle grazing and fishing belong to the original human activities on the floodplain areas. Although these activities have intensified as a result of the recent Sahel drought and the increasing human populations, such relatively small-scale activities do not appear to change the wetland ecosystems irreversibly. This cannot be said of the numerous floodplain reclamation and irrigation schemes, and the attendant river damming projects, that are now being completed, carried out, or planned (Drijver and Marchand 1985).

In response to the threats to the birds using inland wetlands in Africa, a few desk studies have been commissioned by ICBP (Grimmett 1987; Jarry *et al.* 1987; van der

Linden 1988). The positive and significant correlations between the yearly average sizes of the breeding populations of migrant waders and other species in parts of Europe, and the average monthly water discharge values of, for example, the river Niger in the preceding winter, suggest that the foreseen ecological changes in the Sahel wetlands will affect European migratory bird populations (for review, see van der Linden 1988). However, such correlations do not lead to predictions about the consequences for migrant birds of changes in the flooding regimes of the floodplains as a result of dams.

What is needed here are more detailed field studies on the sites. Because no time is to be lost, we advocate the concurrent use of various approaches: research activities involving ringing, counting, monitoring body weights, making feeding observations, and sampling the prey populations should all be undertaken in wetlands in inland West Africa. Studies in which pieces of habitat are manipulated according to the predicted hydrological effects of the planned civil engineering works, in conjunction with such intensive ecological studies, could be especially rewarding and insightful. If the public, the planners, the governments, and the funding agencies take ecology seriously, as they seem to do these days in the case of coastal wetlands in much of western Europe (e.g., Goss-Custard 1987), they should make the resources available for in-depth studies on waders and other water birds in West Africa, both before carrying out, and during the implementation of, the projects.

11.4. Complications in the assessment of coastal wetland sites

The use of 1% criteria has been an effective tool for the identification of important wetlands for wintering waders and waterfowl (Fuller and Langslow 1986) and will continue to be in the future. New 1% criteria stemming from this paper are summarized in Table 12.

Sections 9. and 10. have shown that there are obvious shortcomings in the use of 1% criteria. This is clearly demonstrated through the example of the Sidi Moussa estuary, which does not qualify under the "normal" criteria. Because of a high turnover, however, we can determine that it supports a much higher number of birds and in fact does qualify. The scarcity of intensive population turnover studies of waders during migration periods means that at present it is often impossible to evaluate realistically the numerical importance of sites outside the winter season. This is especially a problem for the evaluation of the small wetlands along migratory corridors (e.g., those along the Moroccan coast and in the Mediterranean). When turnover estimates are available, and when it is known which particular populations are involved, it is possible to apply the numerical criteria given above (based on the wintering numbers of the appropriate populations) to evaluate the conservation importance of a site. We advocate that much more time and energy should be spent in determining the true usage of staging sites by migrating waders.

Some sites have an "additional value," because they act as a moulting place or as a staging site used specifically for laying down large fat reserves. Sites may also act as a cold weather refuge. At such a site, average wader numbers may be rather low in normal years but may increase greatly as a result of severe cold elsewhere. In this case, such a site is of vital importance for a much larger number of birds

Table 12
Population estimates and 1% criteria for all species, subspecies, and biogeographical populations considered in this review

Species	Population estimate	1% criterion suggested
Oystercatcher	874 000	9 000
Black-winged Stilt	6 000	60
Avocet	67 000	700
Common Ringed Plover		
NW Europe	48 000	500
S Europe, Africa	195 000	2 000
Snowy Plover	67 000	700
Black-bellied Plover	168 000	1 500
Knot		
<i>C. c. canutus</i>	512 000	5 000
<i>C. c. islandica</i>	345 000	3 500
Sanderling	123 000	1 000
Little Stint	211 000	2 000
Curlew Sandpiper	436 000	4 500
Purple Sandpiper	50 000	500
Dunlin		
<i>C. a. arctica</i>	15 000	150
<i>C. a. schinzii</i> (Icelandic)	800 000	800
<i>C. a. schinzii</i> (temperate)	21 000	200
<i>C. a. alpina</i>	1 373 000	14 000
Black-tailed Godwit (<i>L. l. islandica</i>)	66 000	700
Bar-tailed Godwit		
European	115 000	1 000
W African	707 000	7 000
Whimbrel	69 000	700
Eurasian Curlew	348 000	3 500
Spotted Redshank	6 500	-
Redshank		
NW European	109 000	1 500
S European, W African	177 000	1 500
Common Greenshank	19 000	-
Common Sandpiper	39 000	-
Ruddy Turnstone		
European	67 000	700
W African	32 000	300

than indicated by average results from counts. The same is true for the Knot example, given in Section 9.2., where the Vendée acts as a reserve staging site under special conditions. This example suggests that it is always better to use maximum, rather than average, counts to evaluate the importance of sites used by a certain species during passage periods. In addition, the arguments given in Section 9.2. indicate that the relative location of a site along a migratory route should be taken into account when evaluating the site. Those staging sites that are used before the final flight to the breeding grounds are likely to be of particular importance. It is clear that numerical data only are unlikely to give a complete picture of the importance of a site for a particular species or population. For a comprehensive evaluation of a site, an understanding of the migratory strategies of its main visiting species is certainly required.

In the future, it will be necessary to carry out counts as well as additional research focussed on feeding ecology and wader catching. Feeding ecological studies provide information on site use, energy intake, and behaviour of the species present, which may be vital information in determining the specific value of a site. Catching and marking may provide information on turnover and additional data on biometrics (Engelmoer *et al.* 1987). These may help to discriminate better between different populations and may be combined with future DNA analyses.

12. Conclusions and recommendations

As a result of more complete coverage of sites supporting populations of wintering waders, and of a variety of additional ecological research connected to the migrations of wader populations, a much more profound understanding of wader migration and site use has evolved than was possible at the time of the previous review of wader numbers by Prater (1976). Not only are we capable of estimating population sizes more accurately, but we are also able to identify wintering population distribution in more detail. Population estimates and the use of the 1% criterion to determine the relative importance of a site have been shown to be very useful tools for conservation purposes (Smart 1987).

Despite the fact that the wader populations and migrations along the East Atlantic flyway are relatively well known, there are still large and important gaps in our knowledge. A more profound understanding of wader population changes and distribution can emerge only by studying the following 14 topics identified by Piersma *et al.* (1987):

- (1) population sizes of waders breeding in the Soviet Union and in countries around the Mediterranean;
- (2) changes in the population sizes of waders breeding in Europe;
- (3) geographical variations in productivity per pair, and per unit area, over breeding ranges in Europe;
- (4) autumn migration patterns of inland waders;
- (5) the relative importance of different coastal moulting sites along the East Atlantic flyway;
- (6) the winter distribution over Europe of open-habitat inland waders (e.g., Golden Plovers, Lapwings, Eurasian Curlews);
- (7) numbers of waders wintering inland in Africa;
- (8) numbers of wintering waders along the Gulf of Guinea (from Guinea to Angola);
- (9) numbers of waders wintering along the nonestuarine coasts of Europe (and Africa);
- (10) population fluctuations of waders wintering in coastal West Africa;
- (11) size and composition of the overwintering wader populations along the East Atlantic flyway;
- (12) spring migration patterns of inland waders;
- (13) migratory pathways of the waders wintering in coastal West Africa; and
- (14) connections involving migrating waders between the East Atlantic and Mediterranean flyways.

Topic 4 is currently under study in a project coordinated by the OAG Münster (1987). Topics 7-14 should form the main topics to be studied by the Wader Study Group and the IWRB Wader Research group. Topic 8 has been the subject of a preliminary desk study, using maritime maps and satellite images to determine the size of mudflat areas (Altenburg 1987; Tye and Tye 1987). Hypotheses emerging from such desk studies will have to be verified in the field. This can be done only by organizing expeditions to carry out surveys and to do ringing work. The latter can supply highly valuable biometrical information relating to the origin of the birds concerned.

Topics 13 and 14 are essential for a more complete understanding of migration routes of waders wintering in West Africa. Areas in the eastern Mediterranean, the Black Sea, and the Caspian Sea deserve much more attention. Even in western Europe there remains much scope for future work. One example is the migration strategy and

biology of the relatively rare temperate Dunlin population. Another example is the incompletely understood way in which waders successively exploit chains of wetlands during migration. It cannot be emphasized sufficiently that migrating waders are ecologically fully dependent on small numbers of wetlands. The total size of these is very small, and the habitat type is in great demand for various kinds of distinctive human exploitation (Smit *et al.* 1987). Many of the sites exploited by wintering and migrating waders are threatened, demonstrating the need for further conservation efforts as well as for the studies mentioned under topics 1-14.

13. Summary

Results of midwinter wader censuses and recent ideas on migration routes and strategies have led to new population estimates for the numbers of waders wintering in western Europe and West Africa. Many wader species wintering in this area, referred to as the East Atlantic flyway, migrate as far south as the Gulf of Guinea. On the East Atlantic coast, approximately 7.5 million waders winter in coastal habitats alone: 3.2 million along the European Atlantic coast, 360 000 in the western part of the Mediterranean, and about 4 million in West Africa. Individual species may use wintering areas beyond the Gulf of Guinea, some species reaching Cape Province, South Africa. Other species, or specific populations, have a more limited winter distribution. Separate subpopulations were distinguished whenever it was possible to link a specific breeding population to a specific wintering area and to recognize this specific population by plumage characteristics or biometrics. For all species or subpopulations, 1% criteria were determined. Sites supporting numbers exceeding these 1% levels were listed and mapped.

For some species, considerable changes in numbers wintering in western Europe were apparent when comparing the present figures with population assessments from the mid-1970s. Some of these differences may be due to real population changes as well as to the greater completeness of recent surveys. The numbers of Knots, Dunlins, and Redshanks appear to have decreased since the early 1970s. Individual sites may be much more important than is apparent from results of counts alone. Sites may show high turnovers of migrating birds, and some have specific functions as moulting areas or as staging areas used to fatten up. Only a combination of counts, ringing work yielding biometrical data, and specific ecological research can give insights into the way waders exploit these sites. Because many coastal wetlands are under serious threat of reclamation, habitat destruction, or pollution, further studies are urgently needed to provide knowledge of still unsurveyed areas, to document changes in numbers and site use in well-known areas, and to evaluate the effects of conservation measures.

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Status of waterfowl, cranes, and other water birds in North America

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1. Abstract

This paper describes surveys conducted to determine numbers and distribution of waterfowl, cranes, and other water birds in North America and discusses the population status, trends, and goals for the various species considered.

2. Résumé

Le présent rapport décrit les relevés effectués en vue de déterminer les effectifs et la répartition en Amérique du Nord de la sauvagine, des grues et autres oiseaux aquatiques. Il contient également une analyse des taux de population de chacune des espèces visées, ainsi qu'une analyse des tendances et objectifs les concernant.

3. Introduction

The Ramsar Convention's criteria for designating wetlands of international importance to waterfowl necessitate an understanding of the numbers and distribution of those birds. As a basis for identifying potentially qualifying wetlands, this paper provides estimates of and indices to certain populations of waterfowl (Anseriformes), cranes (Gruiformes), and other water birds in North America and describes the surveys used in obtaining those data.

4. Surveys

4.1. Duck Breeding Population Survey and Duck Production Survey

The Duck Breeding Population Survey and the Duck Production Survey are conducted cooperatively by the US Fish and Wildlife Service and the Canadian Wildlife Service. The Duck Breeding Population Survey is initiated in early May and ends in mid-June of each year. Its purpose is to determine the species and number of potential breeding ducks in the principal nesting areas of the United States and Canada (Fig. 1, Strata 1-50). Comparable surveys have been conducted since 1955. Aerial counts of ducks are corrected with "visibility rates" derived from sample transects that are censused both from the air and on the ground. In these 50 strata, aerial crews examine 24 817 km² of prime duck habitat along 61 158 km of transect lines. In addition, the status of ducks breeding in California, Wyoming, Colorado, Nebraska, Minnesota, and Wisconsin (Fig. 1) is measured by state wildlife agencies, and resulting data are incorporated into the continental assessments.

The Duck Production Survey, conducted in July of each year, is restricted to the southern strata, i.e., the Prairie provinces and the north-central states. It provides indices to the number, age, and size of broods produced and the number of adult birds that are still on nesting territories, which are used to determine the progress and success of the nesting season.

When both surveys are completed, production information is combined with breeding population information to determine an index to the fall flight of total ducks from each survey unit. These forecasts are then used to determine an overall index, which is allocated among the Pacific, Central, Mississippi, and Atlantic flyways. (See Figure 2 for a map of these four flyways.)

The two surveys provide statistically reliable estimates of the numbers of most species of ducks within the surveyed area. They also provide indices to continental populations. Although the surveyed area contains a large percentage of those species important in the harvest, it does not contain all of them. Therefore, the surveys have obvious limitations in that changes in duck numbers and production outside the surveyed area may or may not follow those within it. Also, the surveys do not estimate adequately the status of some species important in the harvest — e.g., Wood Duck *Aix sponsa* and American Black Duck *Anas rubripes*, most of which breed outside the sampled areas, as well as of those that are of lesser importance in the harvest but are nonetheless numerically important — e.g., Oldsquaw *Clangula hyemalis*, eiders, scoters, and mergansers. Although there is an interest in expanding these surveys to obtain better indices of American Black Ducks, Mallards *Anas platyrhynchos*, and other species important in the harvest, the costs of doing so are prohibitive.

4.2. Midwinter waterfowl surveys

The Midwinter Waterfowl Survey is the oldest of the "continental" surveys, having been conducted in one fashion or another throughout the conterminous United States since 1935. It is a cooperative effort of the US Fish and Wildlife Service and the 48 state wildlife agencies and is organized by flyways. It is conducted annually during the first week in January and is directed at counting all species of waterfowl, coots, and, in some areas, Sandhill Cranes *Grus canadensis* in major concentration areas. It does not represent an estimate of the total population of waterfowl in the United States, and the data are best used as indices to measure trends. However, for some species, such as Tundra Swan *Cygnus columbianus*, the index approaches a close

estimate of the population size, because most of this species winters in areas covered by the survey.

The Mexico Midwinter Waterfowl Survey is conducted cooperatively by the US Fish and Wildlife Service and Dirección General de Conservación Ecológica de los Recursos Naturales. The survey is conducted in five regions — Baja California, West Coast, Interior or Central Highlands, Lower West Coast, and East Coast (Fig. 2). Baja California and the West Coast are surveyed annually in mid-January to determine numbers and distribution of Pacific Brant *Branta bernicla* in coastal waters. All five areas are surveyed for all species of waterfowl, other water birds, and Bald Eagles *Haliaeetus leucocephalus* every third year (January of 1985, 1988, 1991, etc.). Coverage of all waterfowl habitats (both wetlands and uplands) is incomplete, and, therefore, data are best used as indices to populations.

4.3. Fall/winter goose surveys

Several populations of geese are counted during fall surveys when they are concentrated or before they mix with other populations:

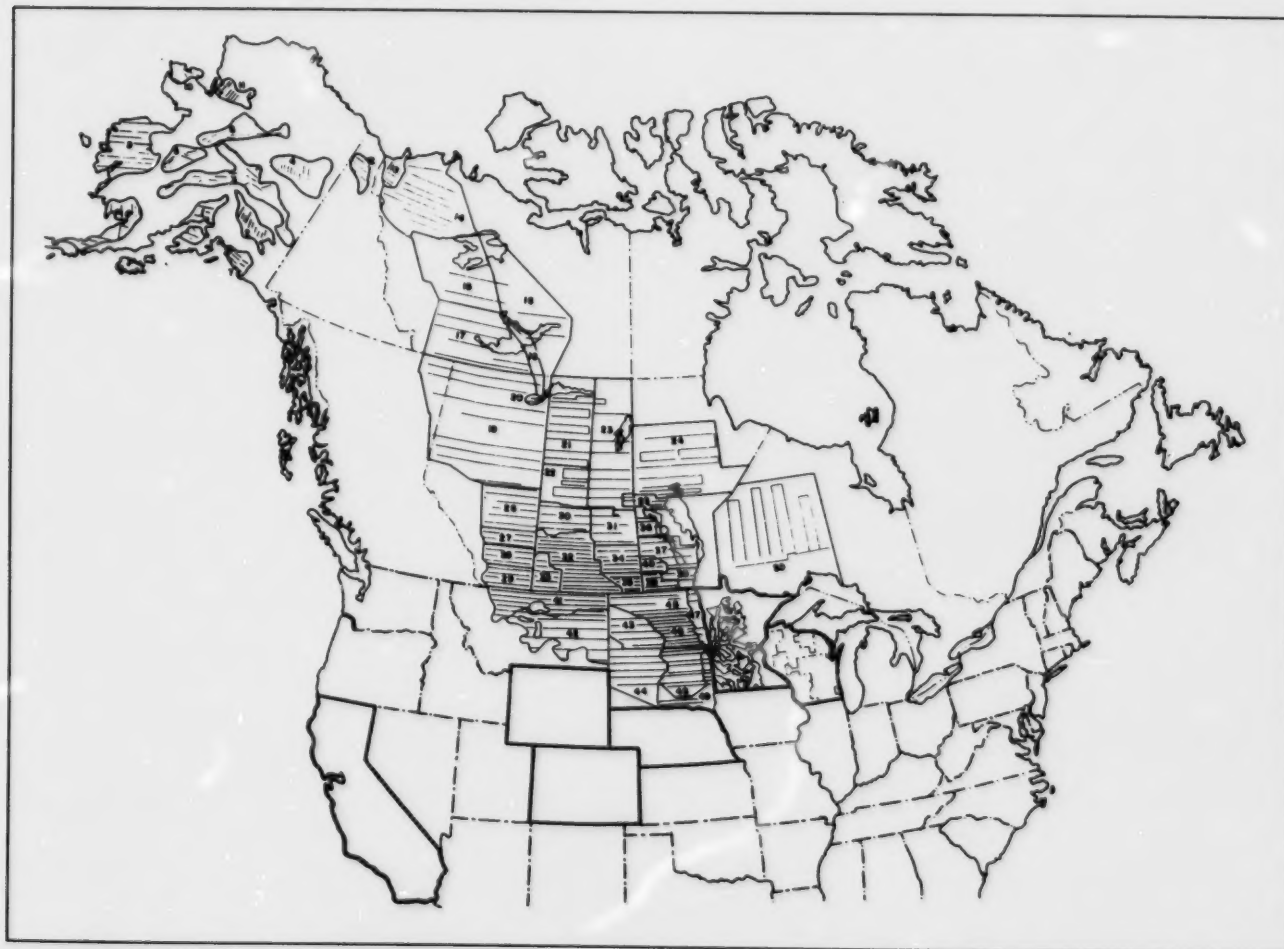
- (1) in the Mississippi flyway, all geese are surveyed during the second week in December;
- (2) in the Pacific flyway, white-fronted geese *Anser albifrons* subspp. are counted during their peak of abundance in the Klamath Basin, which typically occurs from late October to early November; and
- (3) in the Atlantic flyway, Greater Snow Geese *Anser caerulescens atlanticus* are counted in late winter along the US Atlantic coast and again while staging on the St. Lawrence River, Québec, in May.

4.4. Special surveys

Special surveys are sometimes required, because certain important species are either not found in major waterfowl concentration areas or widely dispersed at times of the major waterfowl surveys, and because the status of others is such that special attention must be given to them. Examples include:

- (1) spring surveys for both the Mid-continent and Rocky Mountain populations of Sandhill Cranes;
- (2) summer-autumn surveys of the Trumpeter Swan *Cygnus buccinator* every fifth year throughout its range

Figure 1
Transects and strata (Strata 1-50) of the Waterfowl Breeding Population Survey in Canada and the United States and the states of California, Wyoming, Colorado, Nebraska, Minnesota, and Wisconsin (shown in bold), where independent annual surveys are conducted. Estimates of ducks in these areas collectively constitute the breeding population indices for the "surveyed area."



and biannually for certain flocks; and
(3) periodic photographic inventories of Snow Goose *Anser caerulescens* and Ross' Goose *Anser rossii* colonies in Arctic Canada.

4.5. Breeding Bird Survey

The Breeding Bird Survey is a cooperative program sponsored jointly by the US Fish and Wildlife Service and the Canadian Wildlife Service. Its main purpose is to estimate population trends and relative abundance for many species of migratory birds that nest in North America north of Mexico. Data are collected during the height of the breeding season from a series of stratified routes within various physiographic regions. Each route is run early in the morning and consists of 50 three-minute stops 0.8 km apart along a road. Observers record, on prepared forms, the total number of each bird species heard, as well as those seen within 400 m. Whereas the conventional waterfowl surveys provide better indices for ducks, geese, and swans, this survey provides better indices (but not estimates of the population size) for most other water birds — e.g., herons, egrets, shorebirds, and gulls.

5. Population status

During 1970–79, a period when duck populations were generally high, the continental population of all ducks in the spring was estimated to be about 62 million birds. Table 1 provides estimates of various species and groups of ducks during that period and reflects recent potential for maintaining populations of those sizes. Estimates of ducks within the surveyed areas are statistically reliable. Those of ducks within the unsurveyed areas

are not, but have been based for the most part upon expert opinion and the occasional reconnaissance survey.

Recent breeding population indices and trends for the 10 most common species of breeding ducks in the surveyed area and the population goals for those ducks as identified in the North American Waterfowl Management Plan (NAWMP), published jointly by the US Fish and Wildlife Service and the Canadian Wildlife Service, are listed in Table 2. Table 3 lists indices for those 10 species for the years 1955–80, during which the Duck Breeding Population Survey provided comparable coverage and methodology. In recent years, there have been marked decreases in Northern Pintail *Anas acuta*, Mallards, and Blue-winged Teal *A. discors* in the surveyed area. Intensive agricultural land use on the major breeding grounds, combined with drought that began in 1980 and has continued through 1988 in portions of the Canadian Prairies, has curtailed duck reproduction.

Results from recent Midwinter Waterfowl Surveys in the conterminous United States and in Mexico are shown in Tables 4 and 5, respectively. The index to all species of ducks in the United States was 13.6, 12.9, and 12.3 million in January of 1985, 1986, and 1987, respectively, and compares with the index of 20.6 million in January 1980, before impacts of poor recruitment were manifest.

The status and trends of various species and populations of geese are listed in Table 6. Population goals as identified in NAWMP and by Flyway Councils are also listed. Some of the annual variation in estimated size of a particular population is sometimes attributable to birds not being in the survey area at the time of the survey. Estimates for a few populations are no more than informal guesses, because they were mixed with other populations and reliable estimates of their abundance were not possible. With the exception of certain geese nesting in western Alaska, most goose populations are either stable or increasing.

The status, trends, and population goals for the four species of swans occurring in North America are listed in Table 7.

The status, trends, and population goals for the two species of North American cranes are listed in Table 8.

Figure 2
(Upper) The Pacific, Central, Mississippi, and Atlantic flyways of the conterminous United States (excludes Alaska and Hawaii) as used for delineating populations during Midwinter Waterfowl Surveys and for other migratory bird management and administrative purposes; (lower) the general areas in Mexico covered by the cooperative Mexico Midwinter Waterfowl Survey of the US Fish and Wildlife Service and the Dirección General de Conservación Ecológica de los Recursos Naturales



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Table 1

Estimated average population (in thousands) of breeding ducks^a in both surveyed and unsurveyed areas^b of Canada and the United States, 1970-79 (from Canadian Wildlife Service/US Fish and Wildlife Service 1986)

Species ^a	Surveyed areas ^b			Unsurveyed areas ^b	Continental estimate
	United States	Canada	Total		
Dabbling ducks					
Mallard	2 066	6 675	8 741	1 926	10 667
Northern Pintail	2 332	3 927	6 259	745	7 004
Black Duck	-	88	88	1 340	1 428
Gadwall	512	1 102	1 614	380	1 994
American Wigeon	956	2 315	3 271	216	3 487
Green-winged Teal	482	1 889	2 371	740	3 111
Blue-winged and Cinnamon teal	1 719	3 571	5 290	856	6 146
Northern Shoveler	654	1 415	2 069	100	2 169
Wood Duck	-	-	-	3 230	3 230
Total dabbling ducks	8 721	20 982	29 703	9 533	39 236
Diving ducks					
Redhead	221	539	760	120	880
Canvasback	119	459	578	64	642
Lesser and Greater scaups	1 333	6 243	7 576	322	7 898
Ring-necked Duck	16	533	549	419	968
Ruddy Duck	216	316	532	120	652
Total diving ducks	1 905	8 090	9 995	1 045	11 040
Sea ducks					
Hooded, Red-breasted, and Common mergansers	9	578	587	915	1 502
Bufflehead	82	805	887	195	1 082
Common and Barrow's goldeneyes	126	603	729	740	1 469
Harlequin Duck	-	-	-	165	165
Oldsquaw	600	828	1 428	1 275	2 703
King and Common eiders	22	1	23	2 443	2 466
Black, White-winged, and Surf scoters	346	1 065	1 411	579	1 990
Total sea ducks	1 185	3 880	5 065	6 312	11 377
Total breeding ducks	11 811	32 952	44 763	16 890	61 653

^aNot all North American species of ducks are included in these estimates, only those that are shared mutually by the United States and Canada.

^bThe surveyed areas include Strata 1-50 in Canada and the United States and the states of California, Colorado, Minnesota, Nebraska, Wisconsin, and Wyoming (see Fig. 1). The unsurveyed areas are all other portions of Canada and the United States (except Hawaii, the Virgin Islands, and Puerto Rico).

Table 2

Breeding duck population indices, trends, and goals for the 10 most common species/groups in the surveyed areas^a of Canada and the United States (modified from Canadian Wildlife Service/US Fish and Wildlife Service 1986)

Species/Surveyed area	Breeding population index (in thousands)		Recent trend (1979-86)	Population index goal (year 2000)
	1985	1986		
Mallard				
United States	1 597	2 087		
Canada	3 878	4 264		
Total	5 475	6 351	Decreasing	8 700
Northern Pintail				
United States	1 339	2 003		
Canada	1 596	1 198		
Total	2 935	3 201	Decreasing	6 300
Gadwall				
United States	464	576		
Canada	946	1 014		
Total	1 410	1 590	No change	1 600
American Wigeon				
United States	969	980		
Canada	1 557	1 472		
Total	2 506	2 452	No change	3 300
Green-winged Teal				
United States	433	533		
Canada	1 440	2 035		
Total	1 873	2 568	No change	2 300
Blue-winged and Cinnamon teals				
United States	1 190	2 541		
Canada	2 566	2 122		
Total	3 756	4 663	Decreasing	5 500
Northern Shoveler				
United States	769	1 046		
Canada	1 156	1 357		
Total	1 925	2 403	No change	2 100
Redhead				
United States	167	430		
Canada	539	526		
Total	706	956	No change	760
Canvasback				
United States	126	148		
Canada	285	291		
Total	411	442	No change	580
Greater and Lesser scaups				
United States	1 339	1 435		
Canada	4 893	4 817		
Total	6 232	6 252	No change	7 600

^aThe surveyed areas include Strata 1-50 in Canada and the United States and the states of California, Colorado, Minnesota, Nebraska, Wisconsin, and Wyoming (see Fig. 1).

Table 3

Breeding population estimates^a (in thousands) for the 10 most common species of ducks from surveyed areas^b of Canada and the United States, 1955-86 (US Fish and Wildlife Service/Canadian Wildlife Service 1986)

Year	Mallard	Gadwall	American Wigeon	Green-winged Teal	Blue-winged Teal	Northern Shoveler	Northern Pintail	Redhead	Canvas-back	Greater and Lesser scaups
1955	10 345	1 106	3 333	2 076	6 436	1 965	9 251	733	595	7 100
1956	11 711	1 202	3 712	1 898	6 267	2 084	10 124	928	692	6 595
1957	10 946	1 102	3 208	1 293	5 449	1 744	6 856	684	600	6 535
1958	12 904	687	3 372	1 618	5 799	1 515	6 889	524	713	6 040
1959	10 292	683	3 779	3 153	5 300	1 649	7 228	641	481	8 220
1960	8 206	873	3 165	1 630	4 303	1 859	5 769	542	575	5 566
1961	8 290	1 422	3 219	2 216	4 835	1 625	4 860	437	396	6 764
1962	6 144	1 610	2 721	1 119	3 890	1 633	4 299	664	385	6 398
1963	7 560	1 578	2 209	1 754	4 587	1 435	4 361	396	523	6 564
1964	6 974	1 223	2 690	2 051	4 943	1 685	4 111	560	658	6 326
1965	5 948	1 692	2 695	1 526	4 628	1 607	4 301	568	505	5 383
1966	7 401	1 976	2 901	2 219	5 616	2 272	5 777	747	683	5 421
1967	8 205	1 638	2 637	1 944	4 715	2 244	5 870	846	556	5 877
1968	7 586	2 098	2 783	1 805	3 697	1 811	4 225	502	557	5 971
1969	8 065	1 837	3 192	1 991	4 514	2 150	6 390	759	530	6 338
1970	10 379	1 698	3 752	2 259	5 633	2 269	7 004	834	601	6 930
1971	9 843	1 733	3 425	2 352	5 426	2 052	6 291	693	441	6 149
1972	9 867	1 776	3 428	2 407	5 673	2 505	7 875	489	429	9 527
1973	8 781	1 198	3 665	2 444	4 866	1 657	5 114	754	696	7 535
1974	7 392	1 562	3 003	2 221	5 437	2 060	7 165	613	493	7 045
1975	8 109	1 672	2 862	2 038	6 441	1 994	6 387	974	706	7 846
1976	8 637	1 478	2 699	1 844	5 023	1 818	6 045	946	686	6 973
1977	8 226	1 546	2 678	1 952	4 626	1 616	4 971	688	702	7 490
1978	7 695	1 593	3 808	2 978	4 497	2 162	5 664	833	423	7 125
1979	8 444	1 889	3 388	2 920	5 278	2 555	6 070	774	606	9 135
1980	8 005	1 459	3 857	2 925	4 909	2 050	5 420	1 146	688	7 690
1981	6 757	1 479	3 555	2 515	4 076	2 403	4 227	825	594	7 253
1982	6 684	1 690	3 159	2 247	3 879	2 540	4 112	674	543	6 549
1983	7 107	1 536	2 923	2 574	3 381	2 237	4 086	866	528	8 788
1984	5 974	1 799	3 979	1 804	3 870	2 222	3 664	849	569	8 402
1985	5 475	1 410	2 506	1 873	3 756	1 925	2 935	701	411	6 235
1986	6 691	1 590	2 734	2 588	4 664	2 403	3 201	956	442	6 252
Averages										
1955-60	10 812	900	3 447	1 918	5 424	1 770	7 373	664	612	6 591
1961-65	6 943	1 505	2 695	1 733	4 576	1 597	4 386	525	493	6 287
1966-70	8 327	1 849	3 053	2 044	4 835	2 149	5 853	738	585	6 107
1971-75	8 798	1 588	3 277	2 292	5 569	2 054	6 566	705	553	7 620
1976-80	8 201	1 595	3 286	2 524	4 865	2 040	5 634	877	621	7 683
1981-85	6 399	1 583	3 224	2 203	3 792	2 266	3 805	783	529	7 445
1955-85	8 315	1 492	3 169	2 118	4 895	1 979	5 721	716	567	6 960
Change in 1986 from:										
1985	+16%	+13%	-2%	+38%	+24%	+25%	+9%	+36%	+8%	NC ^c
1955-85 average	-24%	+7%	-23%	+22%	-5%	+21%	-44%	+34%	-22%	-10%

^aAll indices to duck populations are adjusted for visibility bias.

^bThe surveyed areas include Strata 1-50 in Canada and the United States and the states of California, Colorado, Minnesota, Nebraska, Wisconsin, and Wyoming (see Fig. 1).

^cNo change.

Table 4

Indices to waterfowl and coot populations within the conterminous United States, by flyway (see Fig. 2), as estimated by the Midwinter Waterfowl Surveys cooperatively conducted by the US Fish and Wildlife Service and state wildlife agencies during January 1985-87

Species	Atlantic flyway			Mississippi flyway			Central flyway		
	1985	1986	1987	1985	1986	1987	1985	1986	1987
Ducks									
<i>Dabbling ducks</i>									
Mallard	145 900	160 100	149 300	1 968 600	2 168 200	1 924 300	1 037 000	799 800	1 069 500
Black Duck	221 200	225 900	194 100	57 700	96 600	74 100	-	≤50	≤50
Mottled Duck	1 600	1 000	200	52 100	57 500	42 000	33 000	43 400	34 500
Gadwall	10 900	11 000	9 700	612 200	649 300	490 900	174 000	108 000	124 600
American Wigeon	29 300	35 000	40 300	138 200	215 700	160 700	76 000	39 600	76 500
Green-winged Teal	34 800	68 300	64 500	581 300	420 500	234 400	288 000	220 100	541 900
Blue-winged and Cinnamon teal	15 500	22 000	9 200	63 500	84 800	80 300	12 000	13 800	2 600
Northern Shoveler	6 500	8 500	8 200	232 100	155 500	78 800	54 000	68 200	70 300
Northern Pintail	34 000	47 400	36 900	694 200	422 600	250 000	572 000	335 600	516 700
Wood Duck	7 900	2 200	2 200	26 000	31 800	16 900	12 000	8 700	1 700
Whistling-ducks	3 200	500	400	-	-	-	≤50	3 900	-
Total dabbling ducks	510 800	581 900	515 000	4 425 900	4 362 500	3 352 400	2 258 000	1 641 100	2 438 300
<i>Diving ducks</i>									
Redhead	90 900	61 800	30 200	15 900	4 200	7 800	108 000	276 700	322 100
Canvasback	133 500	96 100	128 000	72 300	74 800	48 400	16 000	27 600	17 900
Scaups	311 300	410 900	341 200	673 400	351 100	453 200	76 000	116 200	59 300
Ring-necked Duck	84 900	44 600	59 600	178 100	183 500	186 500	22 000	14 800	21 200
Goldeneyes	37 600	41 100	32 600	26 500	62 400	65 300	33 000	14 100	29 300
Bufflehead	47 300	41 800	62 600	2 800	3 100	2 200	6 000	3 300	5 500
Ruddy Duck	47 900	51 900	76 500	14 200	35 600	13 400	14 000	6 500	16 500
Total diving ducks	753 400	748 200	730 700	983 200	714 700	776 800	275 000	459 200	471 800
<i>Sea ducks</i>									
Eiders	163 400	59 000	66 000	-	≤50	-	-	-	-
Scoters	46 400	29 800	24 100	≤50	≤50	≤50	-	-	≤50
Oldsquaw	11 100	12 500	24 500	3 800	1 200	400	-	-	-
Harlequin Duck	≤50	≤50	-	-	≤50	-	-	-	-
Total sea ducks	220 900	101 300	114 600	3 800	1 200	400	-	-	≤50
Mergansers	62 600	89 400	84 800	11 500	41 000	37 800	115 000	84 500	113 600
Unidentified ducks	2 700	6 200	22 200	1 900	4 900	6 400	6 000	7 700	10 900
Total ducks	1 550 400	1 527 000	1 467 300	5 426 300	5 064 300	4 173 800	2 654 000	2 192 500	3 034 600
Geese									
Brant	146 400	110 300	110 500	-	-	-	-	-	-
Snow/Ross' geese	189 300	99 700	102 000	992 700	584 400	1 013 300	1 043 000	934 000	964 000
White-fronted Goose	-	-	-	81 300	80 400	71 500	156 000	93 000	194 500
Canada Goose	814 200	905 400	744 700	906 600	1 097 300	1 026 400	735 000	533 000	844 700
Total geese	1 139 900	1 115 400	957 200	1 980 600	1 762 100	2 111 200	1 934 000	1 560 000	2 003 200
Swans									
Tundra Swan	93 900	90 900	94 400	400	≤50	100	-	-	≤50
Trumpeter Swan	-	-	-	-	100	100	200	200	≤50
Mute Swan	4 800	4 400	5 300	600	500	800	-	-	-
Total swans	98 700	95 300	99 700	1 000	600	1 000	200	200	≤50
American Coot	390 400	290 700	602 800	452 400	745 000	750 300	209 000	158 000	234 700
Grand total	3 189 400	3 028 400	3 127 000	7 860 300	7 572 000	7 036 300	4 797 200	3 910 700	5 272 500

Pacific flyway			United States total		
1985	1986	1987	1985	1986	1987
1 648 400	1 281 800	1 455 400	4 799 900	4 409 900	4 598 500
-	-	-	278 900	322 500	268 200
-	-	-	86 700	101 900	76 700
35 500	39 700	80 100	832 600	808 000	705 300
425 100	377 200	370 300	668 600	667 500	647 800
141 000	185 300	351 800	1 045 100	894 200	1 192 600
3 700	3 700	1 300	94 700	124 300	93 400
199 800	262 600	294 900	492 400	494 800	452 200
859 300	1 254 800	663 200	2 159 500	2 060 400	1 466 800
200	300	400	46 100	43 000	21 200
-	-	-	3 200	4 400	400
3 313 000	3 405 400	3 217 400	10 507 700	9 930 900	9 523 100
24 000	18 900	22 200	238 800	361 600	382 300
61 100	44 600	31 600	282 900	243 100	225 900
154 500	223 800	87 200	1 215 200	1 102 000	940 900
12 200	13 000	14 200	297 200	255 900	281 500
35 800	41 900	24 500	132 900	159 500	151 700
54 700	46 000	34 800	110 800	94 200	105 100
127 400	73 300	58 000	203 500	167 300	164 400
469 700	461 500	272 500	2 481 300	2 383 600	2 251 800
-	-	≤50	163 400	59 000	66 000
113 600	165 200	62 500	160 000	195 000	86 600
600	600	200	15 500	14 300	25 100
100	300	100	100	300	100
114 300	166 100	62 800	339 000	268 600	177 800
29 900	29 400	30 900	219 000	244 300	267 100
17 000	39 500	14 700	109 600	58 300	54 200
3 943 900	4 101 900	3 598 300	13 574 600	12 885 700	12 274 000
13 200	13 800	16 200	159 600	124 100	126 700
371 000	557 200	336 000	2 596 000	2 175 300	2 415 300
33 100	53 700	70 500	270 400	227 100	336 500
307 400	280 500	354 100	2 763 200	2 816 200	2 969 900
724 700	905 200	776 800	5 789 200	5 342 700	5 848 400
48 800	66 100	52 800	143 100	157 000	147 300
900	1 400	1 400	1 100	1 700	1 500
100	≤50	≤50	5 500	4 900	6 100
49 800	67 500	54 200	149 700	163 600	154 900
162 000	133 800	187 600	1 213 800	1 327 500	1 775 400
4 880 400	5 208 400	4 616 900	20 727 300	19 719 500	20 052 700

Table 5

Indices to waterfowl and other populations of water birds^a within five regions of Mexico (see Fig. 2) as estimated by the Mexico Midwinter Waterfowl Survey cooperatively conducted by the US Fish and Wildlife Service and Dirección General de Conservación Ecológica de los Recursos Naturales during January 1981 and 1985 (adapted from Norman 1981 and Voelzer 1985)

Species	Baja California		West Coast		Interior Highlands		Lower West Coast		East Coast	
	1981	1985	1981	1985	1981	1985	1981	1985 ^b	1981	1985
Ducks										
<i>Dabbling ducks</i>										
Mallard	-	-	-	210	5	1 185	-	-	770	90
Mexican Duck	-	-	-	-	20 965	22 635	-	10	-	-
Mottled Duck	-	-	-	-	-	-	-	-	10 670	1 350
Gadwall	-	-	25 855	19 440	17 915	19 480	290	490	33 690	30 960
American Wigeon	520	50	78 000	87 794	71 190	27 485	10 060	285	158 860	44 290
Green-winged Teal	-	-	172 470	180 256	133 535	88 680	30	405	57 930	30 900
Blue-winged and Cinnamon teals	-	-	141 260	241 776	77 225	38 890	8 785	1 685	104 050	75 005
Northern Shoveler	40	-	63 180	157 459	89 850	78 480	830	3 435	62 355	16 700
Northern Pintail	3 000	215	320 050	265 570	93 740	81 455	1 315	2 030	321 640	69 500
Fulvous Whistling-duck	-	-	15 590	13 900	535	90	275	250	40 360	36 935
Black-bellied Whistling-duck	-	-	18 230	10 630	-	-	1 690	2 340	-	-
Total dabbling ducks	3 560	265	834 635	977 015	504 960	358 580	23 275	10 910	798 265	306 530
<i>Diving ducks</i>										
Redhead	7 900	955	30 280	26 412	640	1 905	200	15	342 910	209 945
Canvasback	10	-	1 640	500	7 005	26 360	4 600	-	26 785	1 450
Scaups	20 860	2 305	43 170	53 083	21 525	9 930	40 170	2 310	152 465	45 630
Ring-necked Duck	-	-	90	21 950	-	4 940	15	20	8 070	1 130
Goldeneyes	-	367	10	545	-	10	-	-	720	-
Bufflehead	100	60	1 630	408	-	20	-	-	1 255	275
Ruddy Duck	10	-	2 610	56 387	8 275	295	1 525	-	8 220	16 975
Total diving ducks	28 880	3 687	79 430	159 287	37 445	43 460	46 510	2 345	540 425	335 465
Scoters	3 440	19	460	192	-	-	-	-	-	-
Mergansers	1 070	1 920	5 740	583	15	145	-	-	695	810
Other ducks	-	-	30	-	-	-	-	-	-	-
Total ducks	36 950	5 891	920 295	1 137 077	542 420	402 185	69 785	13 255	1 331 385	642 745
Geese										
Canada Goose	-	-	-	20	-	260	-	-	9 305	1 630
Brant	160 560	101 405	21 200	30 163	-	-	-	-	-	-
Snow/Ross' geese	-	-	2 230	250	-	83 615	-	-	26 115	18 455
White-fronted Goose	-	-	7 600	2 802	675	12 355	-	-	30 465	18 040
Total geese	160 560	101 405	31 030	33 235	675	96 230	-	-	65 885	38 125
Tundra Swan	-	-	-	-	-	9	-	-	-	-
American Coot	20	-	115 765	68 398	165 150	50 200	53 130	1 630	445 880	224 925
Brown Pelican	3 870	1 467	33 715	16 840	-	2	-	375	-	10
White Pelican	10	152	14 640	5 194	-	1 370	-	4 080	-	-
American Flamingo	-	-	-	-	-	-	-	-	-	-
Wood Ibis	-	-	-	-	-	-	-	62	-	10
White-faced Ibis	-	-	-	-	-	3 775	-	175	-	-
Roseate Spoonbill	-	-	-	-	-	60	-	930	-	-
Sandhill Crane	-	-	450	400	10	20 365	-	-	230	330

^aWith the exception of Baja California and the West Coast areas, species of water birds other than the American Coot *Fulica americana* were given little attention in the other three survey areas until 1985; therefore, useful indices have yet to be developed.

^bSurvey coverage was incomplete.

Table 6

Status and goals for North American goose populations (modified from Canadian Wildlife Service/US Fish and Wildlife Service 1986)

Species/Population	Fall/winter/other population index			Recent trend (1980-87)	Population index goal (year 2000)
	1984-85	1985-86	1986-87		
Canada Goose					
Atlantic Flyway	814 200	905 400	744 700	Stable	850 000
Tennessee Valley	129 300	158 000	129 800	Stable	150 000
Mississippi Valley	477 200	618 900	514 600	Increasing/stable	500 000
Giant ^a	231 900	180 100	151 700	Increasing	100 000
Eastern Prairie	167 600	169 000	182 700	Stable	200 000
Western Prairie	135 000	24 000 ^b	3 100 ^b	Increasing	200 000
Great Plains	17 000 ^c	17 000 ^c	17 000 ^c	Increasing	50 000 ^c
Tallgrass Prairie	207 000	205 000	163 000	Increasing	250 000
Shortgrass Prairie	194 000	173 000	221 000	Stable	150 000
Hi-line	93 000	44 000	96 000	Stable	80 000
Rocky Mountain	90 200	68 300	69 300	Increasing/stable	50 000
Pacific	25 000 ^c	25 000 ^c	25 000 ^c	Increasing	29 000 ^c
Pacific Flyway Lesser	150 000 ^d	150 000 ^d	150 000 ^d	Stable?	125 000
Dusky	7 500	12 200	?	Decreasing	20 000
Cackling	22 800	32 100	51 400	Decreasing	250 000
Aleutian	4 200	?	4 900	Increasing	Delist ^d
Vancouver ^a	?	?	?	Stable?	?
Snow Geese					
Greater	225 000	260 000	304 000	Increasing	185 000 ^c
Mid-continent	1 973 100	1 449 000	1 913 800	Increasing/stable	1 000 000
Western Central Flyway	63 000	97 000	64 000	Increasing	110 000
Western Canadian Arctic	185 000 ^c	185 000 ^c	185 000 ^c	Stable	200 000 ^c
Wrangel Island (USSR)	100 000 ^c	100 000 ^c	100 000 ^c	Stable	120 000 ^c
Ross' Goose	100 000 ^d	100 000 ^d	100 000 ^d	Increasing	100 000
Greater White-fronted Goose					
Eastern Mid-continent	81 300	78 600	71 500	Increasing	65 000
Western Mid-continent	201 000	201 000	201 000	Stable	250 000
Pacific Flyway	93 800	91 700	107 100	Decreasing	120 000
Tule	?	?	?	Unknown	5 000
Brant					
Atlantic	146 400	110 300	110 500	Stable	124 000
Pacific	144 800	128 600	103 200	Stable/decreasing	185 000
Emperor Goose^a	58 800	42 000	?	Decreasing	150 000
Nene^a					Delist ^d

^aA species or population that is not included within the North American Waterfowl Management Plan.

^bIndex does not reflect true status because population could not be readily segregated from other populations.

^cBreeding population index.

^dDelist from its classification as an "Endangered Species."

Table 7

Status and goals for North American swan populations (modified from Canadian Wildlife Service/US Fish and Wildlife Service 1986)

Species/Population	Population index			Recent trend (1980-87)	Population index goal (year 2000)
	1984-85	1985-86	1986-87		
Tundra Swan					
Eastern population	94 300 ^a	90 900 ^a	94 400 ^a	Stable	80 000 ^a
Western population	48 800 ^a	66 100 ^a	52 800 ^a	Stable	60 000 ^a
Trumpeter Swan					
Pacific coast	?	9 600 ^b	?	Increasing	10 000 ^b
Rocky Mountain					2 000 ^b
— Interior Canada	?	604 ^b	?	Increasing	
subpopulation					
— TriState subpopulation	?	507 ^b	?	Decreasing/stable	
Interior	?	209 ^b	?	Increasing	600 ^b
Whooper Swan^c	400?	400?	400?	Stable?	Maintain
Mute Swan^d	5 500 ^a	4 900 ^a	6 100 ^a	Stable	Do not allow it to increase

^aWinter population index.

^bSummer/fall population index.

^cWhooper Swans *Cygnus cygnus* winter in the westernmost Aleutian Islands of Alaska. They are not found in Canada and therefore are not included in the North American Waterfowl Management Plan.

^dMute Swan *Cygnus olor*, an introduced species, is not included in the North American Waterfowl Management Plan.

Table 8
Status and goals for North American populations of cranes

Species/Population	Population index			Recent trend (1986-87)	Population index goal (year 2000)
	1984-85	1985-86	1986-87		
Whooping Crane					
Aransas-Wood Buffalo Flock	86	97	110	Increasing Recruitment through stocking	Delist ^a
Grays Lake-Middle Rio	33	31	26		Establish flock ^a
Grande Valley Flock					
Sandhill Crane					
Pacific Flyway Lesser	25 000?	25 000?	25 000?	Stable	20 000-25 000
Mid-continent (mix of Lesser, Canadian, and Greater)	390 700	320 300	?	Stable/increasing	480 000-590 000
Rocky Mountain Greater	22 000	22 000?	22 000?	Increasing	18 000-22 000
Central Valley Greater	5 000?	5 000?	5 000?	Stable?	4 000
Lower Colorado River	1 500?	1 500?	1 500?	Stable?	1 250-2 600
Valley Greater					
Eastern Greater	16 400	16 000?	16 000?	Stable/increasing	≥12 000

^aDelist from its classification as an "Endangered Species."

Waterfowl population levels in North America and their use in identifying Canadian wetlands of importance for breeding waterfowl

Hugh Boyd

1. Abstract

Most North American waterfowl breed in Canada, and Canadians must be especially concerned with maintaining wetlands for waterfowl production under the conditions imposed by northern landscapes and climates. In this paper, I describe Ramsar sites in Canada's Arctic, sub-Arctic, and boreal wetlands, as well as recent changes in waterfowl numbers and distribution and their potential effects on the identification and protection of wetlands, both those that are clearly of international importance and those that are less obviously important.

2. Résumé

Comme la plupart des espèces de sauvagine de l'Amérique du Nord se reproduisent au Canada, les Canadiens doivent apporter un soin particulier au maintien des zones humides utilisées par ces espèces pour se reproduire, compte tenu des conditions imposées par la géographie et le climat caractéristiques de la partie septentrionale de l'Amérique du Nord. Le présent rapport contient une description des sites Ramsar désignés pour protéger les zones humides des régions arctique, subarctique et boréale du Canada. Il décrit également les changements récents survenus dans les effectifs et la répartition des espèces de sauvagine ainsi que l'effet éventuel de ces changements sur la désignation et la protection des zones humides en fonction de leur importance plus ou moins manifeste au niveau international.

3. Introduction

Bartonek (this publication) summarizes a large amount of information on waterfowl numbers and distribution in North America, collected by the US Fish and Wildlife Service (USFWS), the Canadian Wildlife Service (CWS), the Dirección General de Conservación Ecológica de los Recursos Naturales in Mexico, and many collaborating state, provincial, and nongovernment wildlife agencies during the last 30 years. He also notes some of the population goals for the year 2000 listed in the North American Waterfowl Management Plan (NAWMP), published by the USFWS and CWS (1986). The goals reflect the intention to maintain species populations at not less than their levels during the 1970s and, in some cases, to

achieve substantial increases. The plan makes clear that the preservation and enhancement of wetlands are essential to the attainment of the population goals.

Bartonek does not attempt the massive task of assembling a "shadow list" of wetlands of international importance, and nor shall I. My purpose is to use some of his numbers, and some others, to illustrate a few of the problems encountered by the agencies responsible for waterfowl management in North America in attempting to conserve enough wetlands in good enough condition to enable the goals of the NAWMP to be met. I am concerned with recent changes in waterfowl numbers and distribution and their potential effects on the identification and protection of wetlands, both those that are clearly of international importance and those that are less obviously important.

The majority of North American waterfowl breed in Canada (Table 1). Although the responsibility for the conservation of this highly prized natural resource is shared among Canada, the United States, and Mexico, Canadians must be especially concerned with maintaining wetlands for waterfowl production under the conditions imposed by northern landscapes and climates.

Figures 1 and 2 illustrate the waterfowl habitat areas of major concern in Canada and the United States and the extent to which those areas remain intact and are protected. Figure 3 shows the distribution within Canada of sites already designated as Wetlands of International Importance (Ramsar sites). Figure 4 shows the Wetland Regions of Canada, as defined by the National Wetland Working Group of the Canada Committee on Ecological Land Classification (Energy, Mines and Resources Canada 1986). These maps summarize, on a very broad scale, where our wetlands are and which among the most important of them have been afforded some statutory protection. Canada is extraordinarily rich in wetlands: 755 000 km² of freshwater and 1.27 million square kilometres of other wetlands (peatlands, bogs, etc.) in a total area of 9.97 million square kilometres, the highest proportions in any country in the world.

Table 1
Numbers (in thousands) of ducks and geese breeding in Canada and North America, 1985 (after CWS/USFWS 1986)

Genus/species	Canada	North America
Ducks		
<i>Anas</i>		
<i>platyrhynchos</i>	5 800	7 400
<i>rubripes</i>	950	1 200
<i>strepera</i>	1 100	1 700
<i>americana</i>	2 300	3 300
<i>acuta</i>	2 300	3 600
<i>crecca</i>	2 150	2 600
<i>discors/cyanoptera</i>	3 400	4 600
<i>clupeata</i>	1 300	2 100
<i>Aythya</i>		
<i>americana</i>	650	820
<i>valisineria</i>	360	480
<i>collaris</i>	940	970
<i>marila/affinis</i>	5 300	6 600
<i>Aix sponsa</i>	400	3 500
<i>Oxyura jamaicensis</i>	450	650
<i>Bucephala</i>		
<i>clangula/islandica</i>	1 350	1 500
<i>albeola</i>	1 000	1 100
<i>Clangula hyemalis</i>	2 100	2 700
<i>Somateria</i> spp.	2 400	2 500
<i>Melanitta</i> spp.	1 700	2 000
<i>Mergus</i> spp.	1 400	1 500
Total ducks	37 350	50 820
Geese		
<i>Branta</i>		
<i>canadensis</i>	1 600	1 800
<i>bernicla</i>	160	200
<i>Anser</i>		
<i>albifrons</i>	180	250
<i>caerulescens</i>	1 600	1 700
<i>rossii</i>	100	100
Total geese	3 640	4 050

4. Arctic wetlands

More than one-third of Canadian wetlands are in the Arctic, where human occupation and alteration of wetlands have been and are likely to remain insignificant. Most of the major colonies of breeding geese have been protected as Migratory Bird Sanctuaries and designated as Ramsar sites. Some other areas qualifying as Wetlands of International Importance, according to the revised criteria adopted at Regina in June 1987, have yet to be protected. Some, indeed, have yet to be found.

There is much still to learn about the status of shorebirds breeding in the North. Work now in progress should ensure that the identification of key areas will be virtually completed within a decade. Because shorebirds, and most other water birds, nest in a highly dispersed way in the North, many of the areas to be designated will need to be very large, as are several of the existing Ramsar sites. (The largest, Queen Maud Gulf Migratory Bird Sanctuary, covers 62 000 km² and is nearly as large as the Republic of Ireland or Sri Lanka.) The designation of additional sites in the Northwest Territories has been slowed by delays in the settlement of land claims by several groups of indigenous people. These people, who wish to maintain their traditional way of life, appreciate the need to avoid damaging wetlands and other wildlife habitat, so that recent increases in their involvement in northern land management decisions should be helpful to wetland conservation, even if there continue to be delays in the legal processes of protection.

5. Sub-Arctic and boreal wetlands

There are two Ramsar sites in the territories that are not in the Arctic wetland region. They are of particular interest in the context of this review, because both have been included for many years in the area covered by the aerial surveys in late May, so that there are records of the fluctuations of their waterfowl populations.

The Old Crow Flats in the Yukon (68°N, 140°W), which have long been famous as a concentration area for breeding and moulting ducks, lie in the High Sub-Arctic Wetland Region. The designated area is 6170 km². The area sampled in the May survey is 93.2 km². The numbers of ducks found in the sample are expanded by a factor of 54.7, so as to refer to an area of 5102 km², substantially smaller than the Ramsar site. Thus, the estimates plotted in Figure 5 underrepresent the population of the entire Ramsar site. Nevertheless, the numbers are large, having ranged between 150 000 in 1973 and 518 000 in 1979, with a mean for the period 1955–88 of 300 000 ± 92 000, with no sustained trend. Most of the ducks breeding in the Old Crow Flats are diving ducks (Aythyini). Note that it is difficult to predict the numbers, even for a short time ahead, because of the mixture of periods of relative stability (notably 1965–78) with others of high variability. No production surveys have been carried out on the Old Crow Flats, so that we do not know what relationship may exist between stock size and output there. Nevertheless, the picture is a seemingly comfortable one for managers.

The Peace-Athabasca Delta in northern Alberta (59°N, 111°W) lies in the southeast corner of Wood Buffalo National Park. The May sample covers 81.6 km², extrapolated to represent 4209 km², an area larger than that designated as the Ramsar site (3213 km²), some of it lying east of the park boundary. As the immediate interest lies in recording the variations in numbers over the years, rather than in the (relatively small) proportion of ducks left unprotected by the park, the numbers plotted in the lower part of Figure 5 are those published by the USFWS for the entire delta area. In the Peace-Athabasca Delta, as in the Old Crow Flats, the period from 1966 to 1978 was one of comparative steadiness, with numbers in both areas around 200 000 year after year. From 1955 to 1965, the numbers of ducks found in the delta fluctuated widely around a much higher mean (490 000 ± 211 000), with peaks of 806 000 in 1959 and 952 000 in 1961 and lows of 214 000 in 1960 and 220 000 in 1963. Since 1978, the numbers of ducks have again fluctuated widely, around a mean of 251 000 ± 94 000 and with a downward trend.

The Peace-Athabasca Delta is the most northerly "prairie-type" marsh complex in North America, although lying in the Continental High Boreal Wetland Region. As such, it was a very important base for moulting and staging waterfowl, as well as for breeding ducks (Nieman and Dirschl 1973). A massive change in the hydrological regime of the delta began in 1967, when the W.A.C. Bennett Dam, some 900 km upstream on the Peace River, near Hudson Hope, British Columbia, began to fill. The discharge of the Peace River remained low for several years and has since been regulated in ways far removed from the natural annual cycle. This led to "a progressive deterioration of waterfowl habitat. Many perched basins and small streams have dried up completely and the larger lakes and marshes are showing substantial water level declines.

Figure 1
Waterfowl habitat areas of major concern in Canada and the United States, 1985
(from CWS/USFWS 1986)

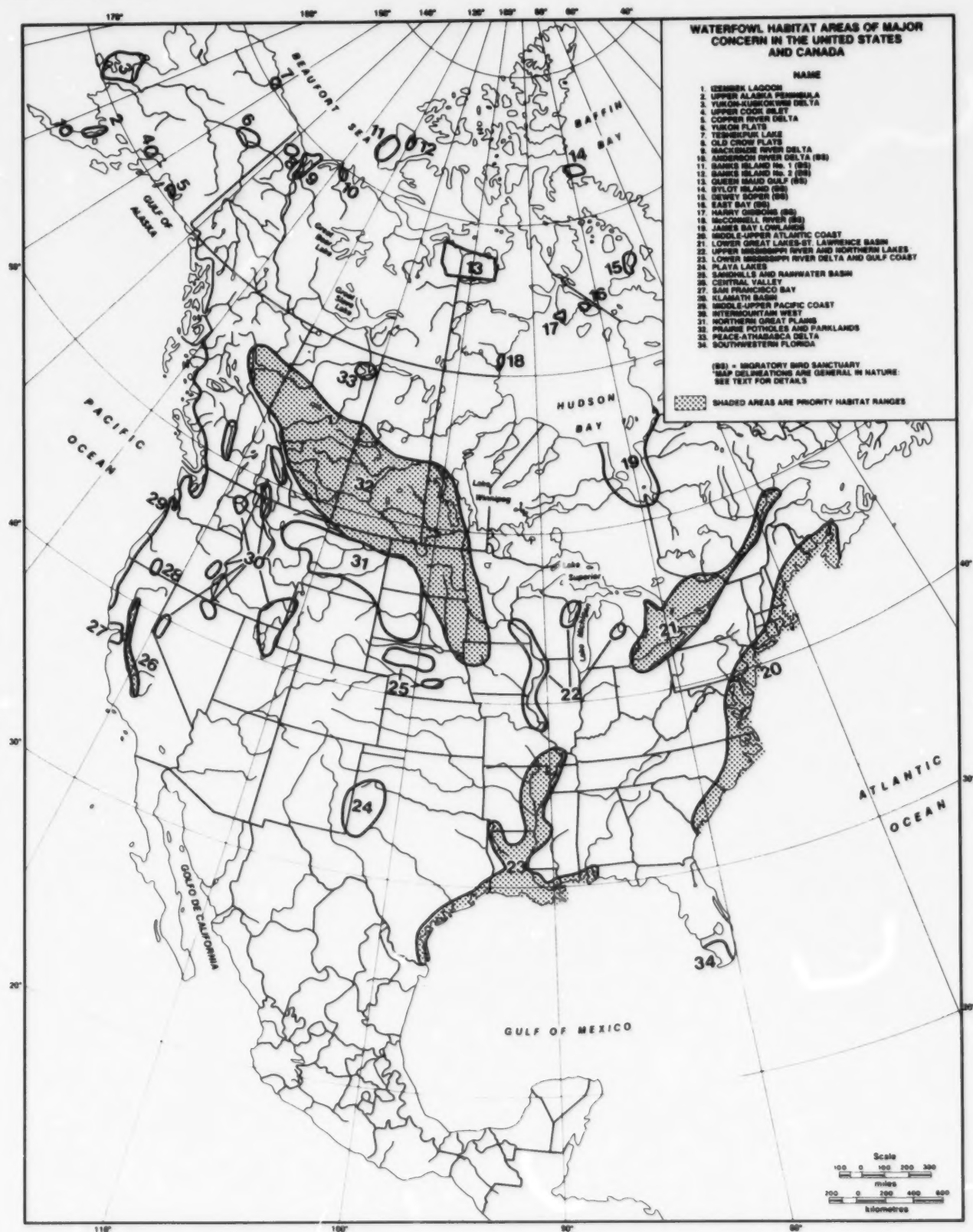
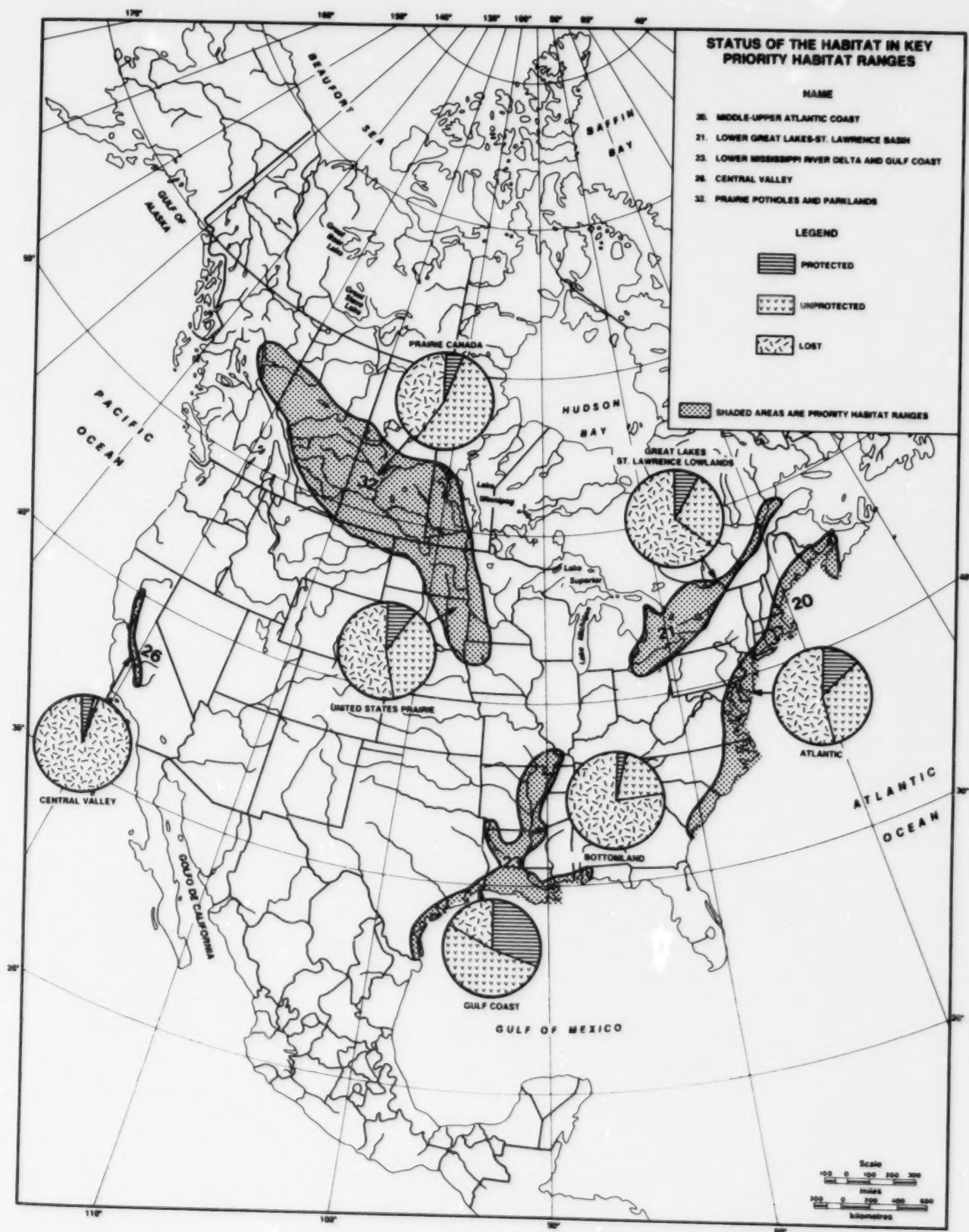


Figure 2
Status of waterfowl habitat in priority breeding and wintering areas of Canada and the United States (from CWS/USFWS 1986)



Waterfowl production habitat on the delta is decreasing and the distribution of the breeding birds altered due to these conditions" (Nieman 1971).

Annual production surveys in July were not begun in the delta until 1966, after the period with very large numbers of ducks. There have been some breaks in the series. The reported indices of young ducks (dashed line in Fig. 5) show a direct association between the numbers of adults in May and young in July, with occasional exceptions. Production in the 1980s has been low.

It is still possible to hope that a new equilibrium between ducks and wetlands is becoming established in the delta, not greatly inferior to that prevailing before the Bennett Dam was built.

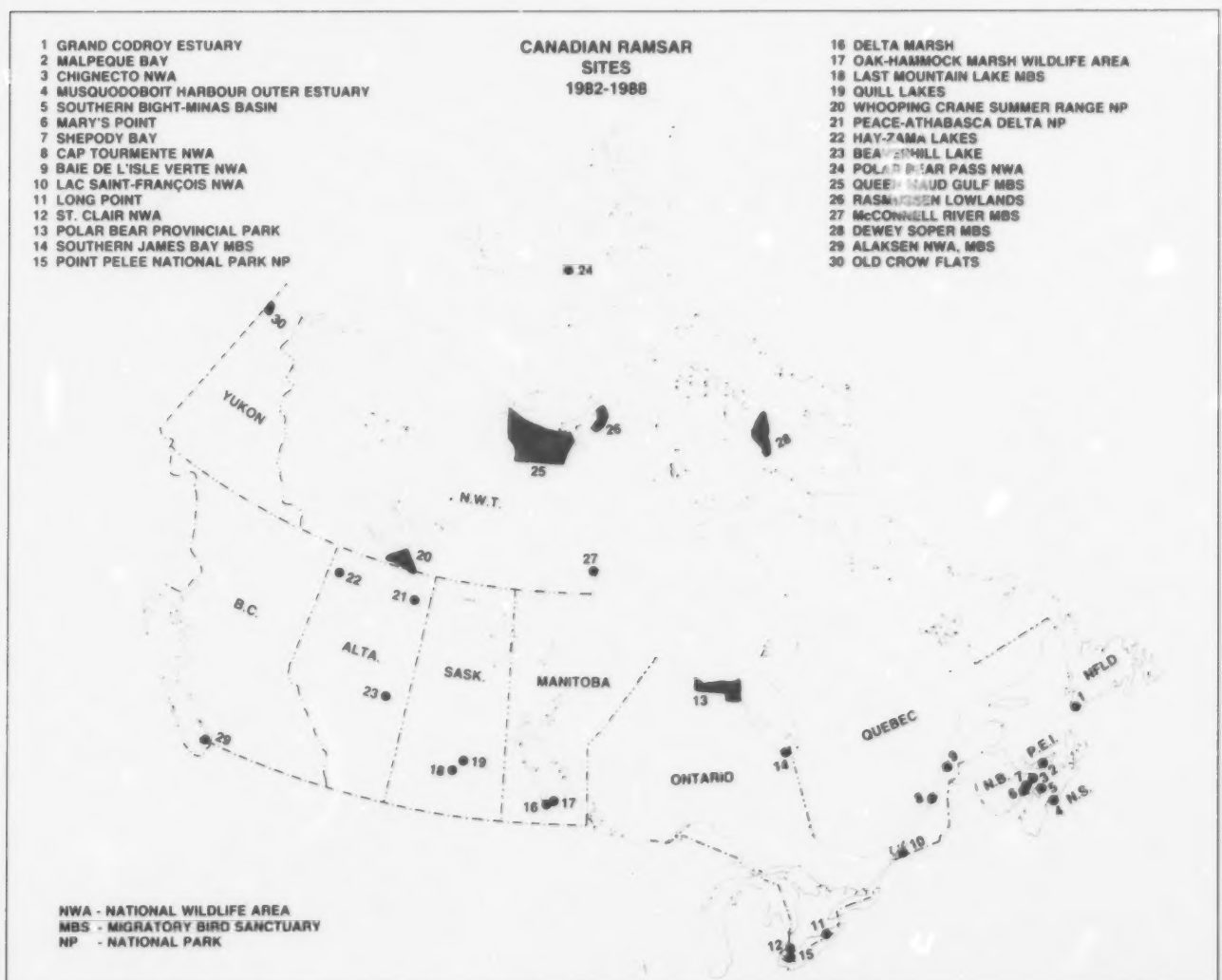
The point of general interest here is the increasingly familiar one that it may be very difficult to maintain the ecological value of a Ramsar site if it is affected by distant events in a different jurisdiction over which the site management agency, even when it is a powerful one (here, the Canadian Parks Service), has no control. Fortunately,

even the badly damaged Peace-Athabasca Delta remains of substantial value to waterfowl.

6. The use of the flyway concept in prescribing population goals

Before turning to some of the issues related to wetland conservation in the Prairie provinces, where agriculture and other human influences on the landscape compete, and often conflict, with the maintenance of wetlands for wildlife, it seems useful to comment on the ways in which populations may be defined, as they have a major influence on the significance and use of the numerical criteria for justifying the classification of a site as being of international importance. The revised criteria adopted in Regina in June 1987 raised the numerical threshold (3.1.a) from "regularly supports 10 000 or more waterfowl" to 20 000. That change perhaps adds importance to the use of the second numerical criterion (3.1.c): "where data on populations are available, it

Figure 3
Ramsar sites, 1982-88



regularly supports 1% of the individuals in a population of one species or subspecies of waterfowl." That 1% has had a remarkable appeal for bureaucrats, but it is obviously fraught with difficulties for biologists, who take the reliability and meaning of numerical information more seriously than do most bureaucrats.

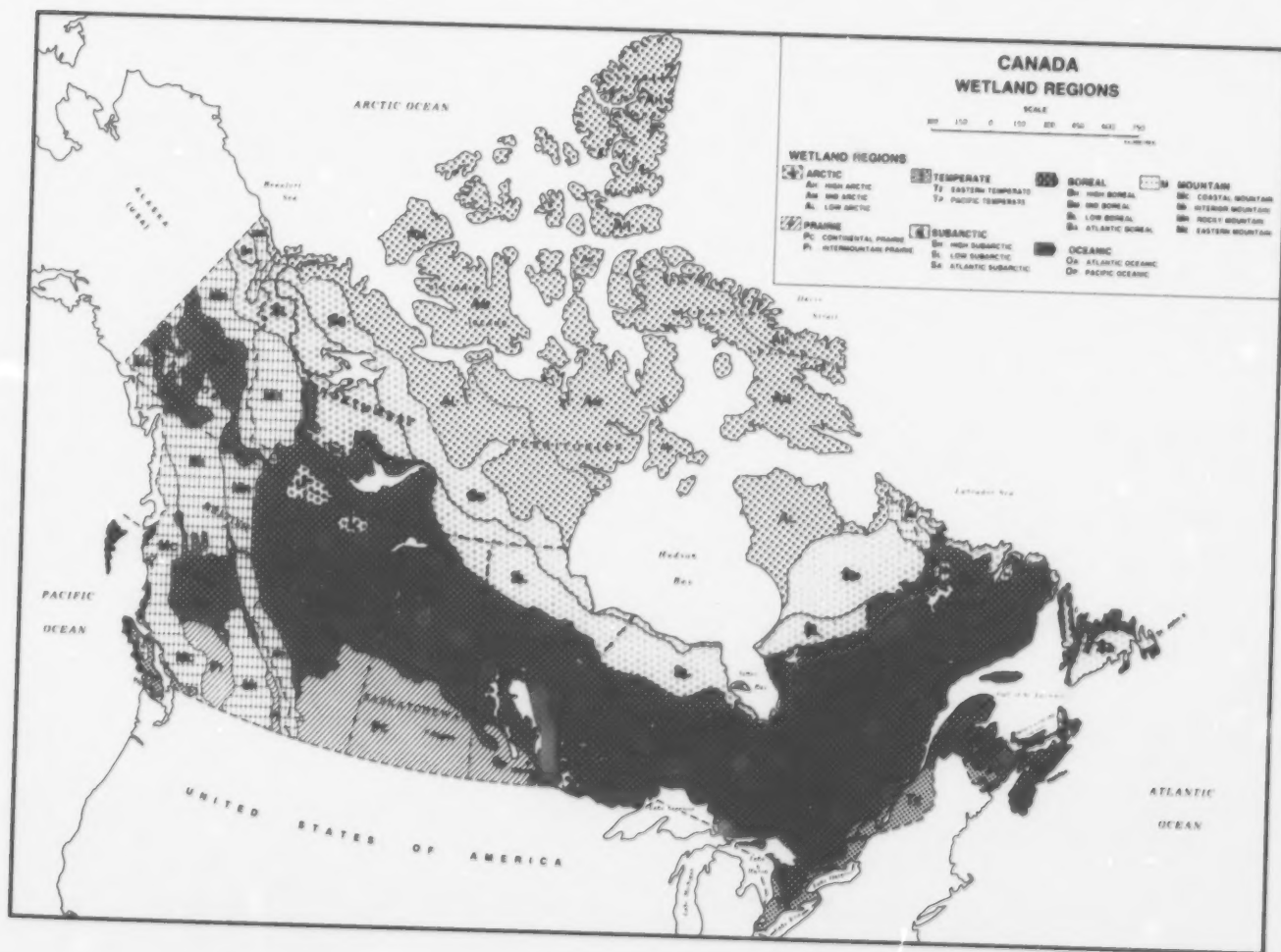
Flyways were an American invention, for an administrative purpose. In 1948, the US Department of the Interior grouped the "lower 48" or "conterminous" states into four regions, termed the Pacific, Central, Mississippi, and Atlantic flyways, separated by boundaries running roughly north-south (see Fig. 2 in Bartonek, this publication). Soon afterwards, four Flyway Councils were established to consolidate and channel advice from the 48 states to the Director of the USFWS, particularly with respect to the federal regulations governing the hunting of migratory game birds, including waterfowl. Thus, flyways were devised to help in managing the exploitation of waterfowl within a single country.

In recent years, the concept of flyways has been

taken up in other parts of the world, with a substantially different emphasis, exemplified in other contributions to this workshop. Smit and Piersma (this publication) discuss the expanded concept at some length, noting that whereas the term flyway can best be used to describe the movement of a specific population, it can also deal with an amalgamation of migratory routes of a group of species (waders, in their case). The East Atlantic flyway they use covers an enormous area, from the eastern Canadian Arctic and northern Siberia to the southern tip of Africa, with special emphasis on the coasts of western Europe and West Africa. Thus, these "biological flyways" include many countries and ignore national boundaries.

Although Canadian waterfowl biologists are accustomed to hearing Americans talk about their flyways, they do not find it useful to extend their north-south boundaries into Canada. Waterfowl from Canada, especially ducks, do not simply migrate south in autumn but move more or less obliquely, so that birds from a single province may winter in two or more flyways. Because of

Figure 4
Wetland Regions of Canada (from Energy, Mines and Resources Canada 1986)



their strong female philopatry, geese form more or less closed subpopulations and can best be managed in that way (although some of the American management units, such as the Tennessee Valley Canada Goose unit, are amalgams of groups of geese that taxonomists would separate quite differently). Few North American ducks split themselves into identifiable subpopulations. (Barrow's Goldeneye *Bucephala islandica* and the Harlequin Duck *Histrionicus histrionicus* are striking exceptions. Each has a Pacific and an Atlantic stock, with none in the interior.) Thus, for management purposes it is necessary to use political boundaries, rather than biological ones, to define our duck populations. This has both advantages and disadvantages when trying to use numerical population criteria to establish the importance of key wetlands.

7. Application of numerical criteria in western breeding areas

In the prairies and parklands of western Canada, most of the wetlands and their surrounding uplands have been greatly altered by man since settlement by European farmers in the mid-19th century. The changes have intensified and accelerated in the last 30 to 40 years, with increasingly massive machinery and the heavy use of fertilizers and other chemicals for pest and weed control. These activities have reduced the carrying capacity of the wetlands and their surrounds, with sustained adverse effects on both the numbers of ducks and their productivity

(Fig. 6), although farther north the numbers of ducks have held up well.

The NAWMP proposes to slow down or reverse these trends, if funding can be sustained, by projects to improve waterfowl habitat by changing land use practices on 1.46 million hectares in Prairie Canada, equivalent to nearly 7% of the farmed land. The intention is not to compete with farming on the best agricultural land, but to concentrate on land use in areas of lower agricultural capability but high capability for waterfowl production. In this context, it may be instructive to consider how much land (wetlands and surrounds) might be needed to meet the Ramsar site criterion of supporting 20 000 (breeding) waterfowl. Ducks were very numerous in the 1950s and scarcer in the 1980s. The mean densities of adult ducks in May during the intermediate years 1966-82 were about 30 ducks per square kilometre in the parklands and 27 in the prairies. At those densities about 67 000 ha of parkland or 74 000 ha of prairie land would be required to support 20 000 ducks. Each area is equivalent to the extent of 200 average-sized farms in those regions.

The Canada Land Inventory (CLI), conducted in the late 1960s and early 1970s, produced maps of the capability — not actual use — of land for various purposes, including farming and use by waterfowl. In 1979, the Lands Directorate of Environment Canada, at the request of CWS, undertook an analysis of the extent of overlap between those potential uses of land in the southern Prairie provinces. The results are too complicated to be illustrated

Figure 5
Numbers of ducks (in thousands) using the Old Crow Flats and the Peace-Athabasca Delta in late May, 1955-88. The dashed lines in the Peace-Athabasca Delta graph show the numbers of ducklings seen in July.

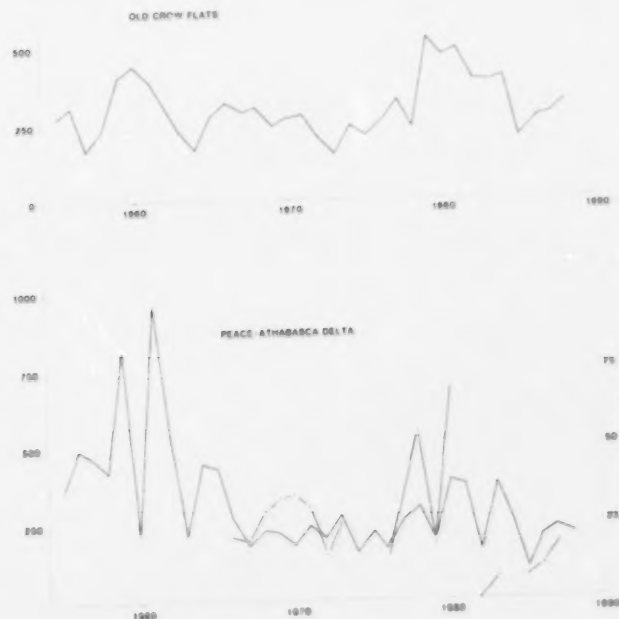
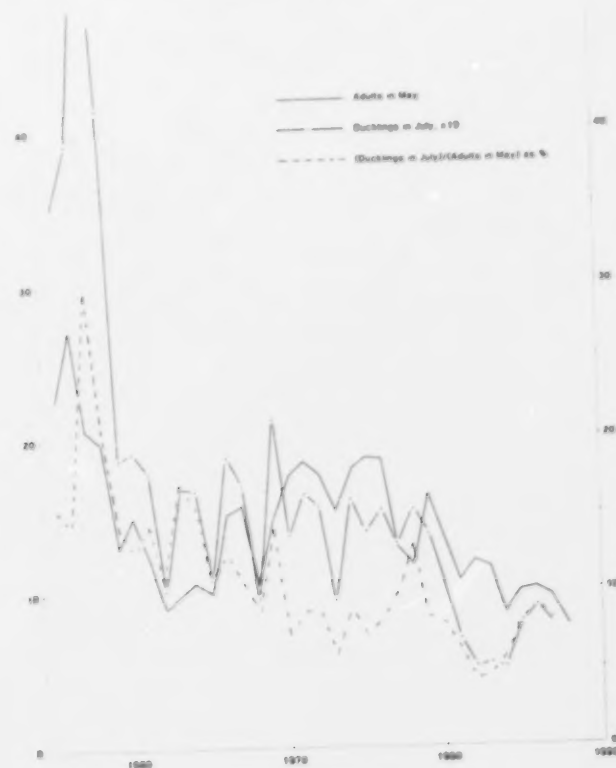


Figure 6
Numbers of adult ducks (in millions) in the Canadian prairies and potholes in May 1955-88; and numbers of ducklings ($\times 10$) seen in July



in any detail without the use of overlays. They are summarized at the provincial level in Table 2 (see also Boyd 1985), which shows that even in these famous "duck factory" provinces, land of high capability for waterfowl production is scarce and less than half as abundant as good agricultural land. Table 2 shows too that two-thirds of the best potential duck breeding areas coincide with high-quality farmland, which helps to explain why farming has resulted in much-reduced duck production. It is improbable that production of wild migratory ducks can be made as profitable to landowners as the production of crops or domestic stock. Nor can any government envisage converting large tracts of land, now in private hands, into "wild duck farms."

The best chance of maintaining or restoring intensive and successful duck breeding lies in the 48 000 km² of land with high waterfowl breeding capability and lower agricultural capability, forming some 9% of the farmed land. (Few very good waterfowl production areas in the Prairie provinces lie north of the settled lands, the Peace-Athabasca Delta being one of the exceptions.)

How far "incidental" duck production on farmed land might be enhanced by the use of suitable techniques can only be answered reliably site by site. For exploratory purposes, on the provincial scale appropriate to this review, some guidance can be found by looking at the peak duck densities attained in survey strata 26-40 (see Fig. 1 in Bartonek, this publication) at any time in the period since 1966. (It seems unhelpful to use the higher numbers from the 1950s, when the impact of farming on wetlands was much less.) The peak densities range from only 9.4 per square kilometre in southeastern Manitoba to 66.7 in southeastern Saskatchewan; six of the 15 strata had peak densities over 50, only two had less than 10, and the regional mean was 41.7 ducks per square kilometre. These numbers can be used to assess the amounts of good duck breeding land needed to support 20 000 ducks. Similar calculations can be made to estimate how much high-capability land might be needed to support 1% of the Canadian (or North American) population of those ducks that nest predominantly in the Prairies, i.e., most of the dabbling ducks (Anatini).

As soon as the need is put in that way, a paradox emerges. Managers have to contend with the problem that the numbers of ducks in the southern Prairie provinces in May in 1984-88 (9.8 ± 1.0 million) have been scarcely half of what they were in 1970-76 (18.5 ± 1.3 million) and little more than one-third of the recorded peak of 27.7 million in 1956. For the purpose of defining wetland management goals for a recovery program, the numerical Ramsar criteria are of little help, because they take no account of population fluctuations, nor of variations in the capacity of wetlands to hold water and waterfowl.

In effect, both "20 000 waterfowl" and "1% of a population" put a premium on scarcity: the fewer ducks there are, the more important site X, which held 50 000 ducks last May, appears to be. Yet, if we seek to double the number of ducks in the Canadian Prairies by the year 2000, rather than retain what we now have, increasing the protection afforded to site X, or the habitat quality within it, is unlikely to contribute very much. This has been a continuing problem with efforts to increase duck production by intensive management of wetlands. The expenditure of a great deal of effort and money has certainly affected the local abundance of ducks near such

Table 2

Areas (in thousands of square kilometres) of land in the Prairie provinces of Canada with high capability for agriculture and for breeding waterfowl, in relation to area of farmed land and total area of each province (capability data from Canada Land Inventory; land use areas from Agricultural Census, 1981)

Parameter	Alta.	Sask.	Man.	Total
Total land area	638.2	570.1	547.7	1756.0
Farmed land	191.1	259.5	76.2	526.7
High capability for agriculture (A)	112.9	191.2	57.0	361.1
(% of total land)	(17.7)	(33.5)	(10.4)	(20.6)
High capability for breeding waterfowl (B)	45.9	82.5	15.9	144.3
(% of total land)	(7.2)	(14.5)	(2.9)	(8.2)
High capability for both agriculture and waterfowl	24.1	60.6	11.6	96.2
(% of high agriculture, A)	(21.3)	(31.7)	(20.3)	(26.6)
(% of high waterfowl, B)	(52.5)	(73.4)	(72.7)	(61.7)
Good for waterfowl, less good for agriculture	21.8	21.9	4.3	48.1
(% of total land)	(3.4)	(3.8)	(0.8)	(2.7)

intensive projects; however, because ducks are dispersed nesters in most places most of the time, the net additions to the prairie fall flight from the intensively managed projects are acknowledged to have been small (2-5% of the regional output). Techniques for increasing the numbers of breeding ducks, and their productivity, need to be applied on a very broad scale to have a large effect. The increments to the output from a region of 550 000 km² that can be achieved by intensive management will always seem small. Thus, the emphasis put in the NAWMP on changing land use practices, rather than on the acquisition and intensive management of high-quality wetlands, is surely correct.

Some of us have worked to devise criteria for Wetlands of International Importance that would be more suitable than those now existing for use in northern lands. (This topic was addressed in detail in Workshop A.) In duck production areas such as the prairies and parklands of western Canada, the most important need is not to preserve the "jewels in the crown," but for Contracting Parties to promote, in accordance with the second part of Article 3.1 of the Ramsar Convention, "the wise use of wetlands in their territory" by whatever means are appropriate. For duck production, the matrix of the crown is more important than the jewels.

This requires a major shift in program emphasis, which carries some risks. Just as it is easier to raise funds to build a laboratory than to keep it operating once built, agencies (whether government or private) will prefer to establish reserves that can be included in the Ramsar List than to spend money and effort on changing land use practices by farmers and others. Doing good by stealth incurs the penalty that you cannot readily show that your efforts have been responsible for what has happened, however beneficial to your cause the changes may have been.

The most important point for us to keep in mind is that the purpose of the Ramsar Convention is to improve the likelihood of maintaining wetlands, particularly in conditions that make them suitable for waterfowl to use. Nothing is to be gained by taking any set of criteria too seriously. It might be a mistake to debase the status of major wetlands by allowing too many sites to qualify as Wetlands of International Importance, but we have to employ procedures appropriate to regional circumstances. This means, in many cases, using national, rather than

continental, criteria or, in very large countries, such as Canada and the United States, using regional boundaries — those of individual provinces or states, or of groups of smaller states. The use of several alternative approaches to classification and designation, rather than a single system, may distress the tidy-minded. But waterfowl are neither biogeographers nor taxonomists. It is better for us to employ the great variety of distribution strategies and population groupings that they adopt than to risk penalizing them for not playing according to our rules.

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Shorebird flyways in the New World

R.I.G. Morrison and J.P. Myers

1. Abstract

Knowledge of flyways used by shorebirds in the New World has increased considerably over the past 10 to 15 years through international research programs designed to identify the key areas used by the birds throughout their ranges. These programs have included volunteer survey networks, specific ground investigations, and aerial surveys of remote areas. Some species breeding in the far northeast and northwest of the North American Arctic migrate to wintering areas in Europe and the Pacific/Asia, respectively, whereas most species breeding across the rest of the Arctic winter in the New World, some as far south as Tierra del Fuego. Major migration flyways in North America are found through James Bay and Hudson Bay, through the eastern seaboard, through the interior of the continent, through the western Gulf of Mexico, and along the Pacific coast. In South America, flyways pass along the northern and Atlantic coasts, across Amazonia by various routes following the major river systems, along the Atlantic coast, down the Andes chain, and along the Pacific coast. Species often follow an elliptical route, with their southward path east of their northward one. Aerial surveys conducted between 1981 and 1986 have identified the major wintering areas on the coast of South America.

Shorebirds concentrate markedly during migration and on the wintering grounds, with a restricted number of sites holding large percentages of populations. The results have enabled key sites used by the birds to be identified throughout their ranges and have demonstrated the conservation importance of such areas. The work has led directly to a new international conservation initiative involving the proposal to link the key breeding, staging, and wintering areas into a Western Hemisphere Shorebird Reserve Network.

2. Résumé

La connaissance des couloirs de migration utilisés par les oiseaux de rivage du Nouveau Monde s'est enrichie considérablement ces dix à quinze dernières années grâce aux programmes de recherches menées au niveau international en vue de déterminer les habitats stratégiques utilisés par les oiseaux le long de leur aire de répartition. Ces programmes ont pris diverses formes, qu'il s'agisse de réseaux d'inventaires confiés à des bénévoles, de recensements terrestres ponctuels ou de relevés aériens

menés dans les régions éloignées. Tandis que certaines espèces qui se reproduisent dans les secteurs est et ouest de l'extrême-Arctique canadien émigrent dans des aires d'hivernage situées en Europe et dans le complexe Pacifique/Asie, la plupart des autres espèces qui se reproduisent ailleurs, dans l'Arctique, hivernent un peu partout sur le continent américain, et certaines se rendent même aussi loin dans l'hémisphère Sud que la Terre de feu. Les principaux couloirs de migration fréquentés par ces oiseaux de l'Amérique du Nord sont situés le long de divers axes qui tantôt traversent la baie James ou la baie d'Hudson, le littoral de l'Atlantique ou l'intérieur du continent, ou l'ouest du golfe du Mexique ou qui tantôt longent la côte du Pacifique. En Amérique du Sud, ces couloirs longent les côtes nord et atlantique ou traversent l'Amazonie par diverses routes parallèles aux principales voies d'eau, longeant successivement la côte atlantique, le pied des Andes et la côte pacifique. Les espèces suivent souvent une courbe elliptique, leur migration vers le sud s'effectuant par une voie qui se trouve à l'est de celle vers le nord. Des relevés aériens effectués de 1981 à 1986 ont permis de localiser les principales aires d'hivernage situées le long des côtes de l'Amérique du Sud.

On a relevé des rassemblements importants d'oiseaux de rivage en période de migration et sur les aires d'hivernage et la présence d'importants effectifs répartis sur un nombre limité d'emplacements. L'analyse des résultats a permis de déterminer les habitats vitaux utilisés par les oiseaux suivant leur aire de répartition et a fait ressortir l'importance de ces habitats pour la conservation de ces espèces. Ces travaux ont conduit à une initiative internationale visant à regrouper les zones-clés de nidification, de repos et d'hivernage de ces oiseaux en un Réseau de réserves pour les oiseaux de rivage de l'hémisphère occidental.

3. Introduction

The last 10 to 15 years have seen many advances in our knowledge of the distribution, abundance, and migration routes of shorebirds breeding in Arctic and sub-Arctic areas of the New World. Their wintering areas are found not only in the New World itself, but also in various parts of the Pacific and on the European seaboard (Morrison 1984). This paper aims to provide an overview of present knowledge of flyways used by New World populations of shorebirds.

4. New World flyway studies

Lincoln (1950) introduced the term "flyway" to describe the main migration corridors used by different populations of waterfowl moving between breeding and wintering areas in North America. The concept may also be applied broadly to the movements of shorebird populations. Two types of information are needed to define shorebird flyways: identification of the key sites used by the birds at different times of the year, and migration studies involving banding/marking, to define links between the various sites.

Cooke (1910) and Bent (1927, 1929) provided early summaries of what was known of shorebird migration and distribution in North America, and Wetmore (1926, 1927) reported observations from wintering quarters in South America. Such reviews, however, did not contain enough data to enable a quantitative assessment to be made of the relative importance of various locations over a wide geographical area. Difficulties of access to and travel in many remote areas used by shorebirds precluded wide-scale coverage of key regions, and it was not until the relatively recent use of aerial surveys that information from such areas has become available.

Large-scale investigations were begun in the early 1970s to determine shorebird distribution patterns and identify key sites over wide geographical areas, using two main methods. The first involves the organization of networks of volunteer observers, whose members count shorebirds at regular intervals in a standardized fashion in their own local study areas. The International Shorebird Survey (ISS) scheme was set up in 1974 in eastern North America, with independent but collaborative operations being coordinated in Canada by the Canadian Wildlife Service and in the United States and points south by the Manomet Bird Observatory, Massachusetts. This type of operation is well suited to areas where there are enough volunteers, adequate ground access, and sufficient local knowledge to result in major areas becoming known and being covered. Such an operation provides data on the phenology of migration and on the details of the species present more readily than aerial surveys. Since 1974, some 387 sites have been covered on ISS surveys in Canada in the autumn, and some 210 in spring and 454 in autumn in the United States (Manomet Bird Observatory 1986). A similar scheme was run in California from 1969 to 1974 (Jurek 1974). Data on particular areas have also been gathered through specific investigations (e.g., St. Lawrence River, Broussard 1981; coast of Argentina, Harrington and Morrison 1980). Single-species programs have also been conducted, for instance along the Pacific coast of the United States on the Snowy Plover (Page *et al.* 1986) and on a continental basis for the Piping Plover (Haig and Oring 1985) and Sanderling (Myers *et al.* 1985) (for scientific names of species mentioned in the text, see Appendix 1). Information from all these surveys has provided much of the database for identification of critical sites for shorebirds in North America (Sanner and Howe 1984; Manomet Bird Observatory 1986; Myers *et al.* 1987a, 1987b).

In Alaska, research on the use by birds of coastal areas in the state has been carried out since 1975 by many university groups and agencies under the Outer Continental Assessment Program. During the subsequent decade, researchers accumulated a vast amount of data relating bird densities to season, habitat, and location for

much of the extensive coastline of Alaska, using the complementary approaches of large area surveys by aircraft, boat, and foot, combined with site-specific intensive studies of seasonality and habitat use in coastal bird populations. For example, Woodby and Divoky (1983) reported results of over 2000 km of aerial surveys covering the Norton Sound section of the Bering Sea coast of Alaska. Complementary detailed site studies within the same area were reported, for instance, by Shields and Peyton (1979).

For remote areas, aerial surveys often provide the only effective way of assessing use by shorebirds. Some losses of accuracy in counting and in specific identification are usually more than compensated for by the wide geographical perspective and extent of coverage that becomes possible. The most extensive aerial survey operation to date has been the South American Shorebird Atlas Project, carried out under the Latin American Program of the Canadian Wildlife Service; in this project, most of the coastline of South America likely to contain shorebird habitat was surveyed between 1981 and 1986. This led to the identification of major wintering areas for a number of species (Morrison 1983, 1984; Morrison *et al.* 1985; Morrison and Ross 1989). Aerial surveys have also been used to identify and document major staging areas in James Bay (Morrison 1983, 1984) and in Delaware Bay (Dunne *et al.* 1982).

Banding studies provide not only essential information on the movements of birds between important areas, but also many valuable data on the purposes for which birds are using the areas and on their general biology — e.g., changes in weight, moult, morphometrics, and turnover rates. Band recovery rates are generally very low for shorebirds, most of which are no longer legal quarry in North America, and colour-marking is usually employed to provide more information. Most major banding operations have taken place within the last 20 years and have included large-scale operations, such as those in the Magdalen Islands (McNeil and Burton 1973, 1977), in James Bay (Morrison 1984), and in Suriname (Spaans 1978, 1979), as well as projects directed more towards single species, such as the studies of Red Knot by Harrington and co-workers (Harrington 1982; Harrington *et al.* 1988), of Semipalmated Sandpipers by Lank (1979, 1983), and of Sanderling by Myers and associates (e.g., Myers *et al.* 1984, 1985). Continent-wide marking schemes and projects have been coordinated under the Pan American Shorebird Program (Myers *et al.* 1983, 1984).

5. Migration systems in the New World

Three main migration systems are found among New World shorebirds (Morrison 1984).

The first involves species that breed in the northeastern Canadian high Arctic and migrate to wintering areas on the European seaboard. Northeastern Red Knots and Ruddy Turnstones reach their breeding grounds after a flight from the major European estuaries to staging grounds in Iceland, followed by a flight across the Greenland ice cap (Salomonsen 1950-51; Morrison 1975, 1977; Wilson 1981; Alerstam *et al.* 1986). Recent studies have indicated that some Red Knots may also reach the Canadian high Arctic via staging grounds in northern Norway (Davidson *et al.* 1986).

The second system, which includes the majority of species, involves shorebirds breeding across the North

American Arctic and wintering in North, Central, and South America. Major migration flyways occur along the Atlantic and Pacific coasts, as well as through the interior of the continent in both North and South America. Some species, particularly those moving along the Pacific coast, tend to remain within one flyway, whereas others use two or more: their migration routes form an elliptical pattern, with their southward path in autumn farther east than the northward journey in spring (Morrison 1984; Morrison and Myers 1987; Myers *et al.* 1987a).

The third system involves species breeding in Alaska and migrating to wintering areas in the Pacific and Asia. Some species may winter on Pacific islands, some in Australasia, and some along the Asian coast; for Ruddy Turnstones, at least, there is evidence of an elliptical pattern of migration southwards through the Pacific islands and northwards up the Asian coast (Thompson 1973).

6. Breeding areas

Until the advent of air travel, the breeding distribution of shorebirds in the eastern Arctic remained poorly, or at least patchily, known. By the 1960s, enough information was available from collecting and other expeditions (e.g., Parmelee and MacDonald 1960; Parmelee *et al.* 1967) for Godfrey (1966) to outline the breeding ranges of shorebirds in the Canadian Arctic. Knowledge of Alaskan ornithology developed somewhat earlier (Gabrielson and Lincoln 1959). Many early investigations were concerned primarily with distributional/avifaunal studies. Later work has been concerned more with quantitative studies or syntheses of information on breeding biology (e.g., Norton 1972; Pitelka *et al.* 1974; Ashkenazie and Safriel 1979a, 1979b). Although the breeding ranges of the birds are now known reasonably well in outline (Godfrey 1986), few estimates of breeding densities exist in relation to the enormous areas involved (e.g., Freedman and Svoboda 1982). Very little information exists on where the centres of species' populations may be, in terms of either densities or overall numbers, on the extent to which breeding densities may vary from year to year, or on population levels over the long term. Some parts of the Arctic that appear to contain habitat highly suitable for breeding shorebirds remain very incompletely known, for instance the islands and coastal lowland tundra of the Foxe Basin (Morrison and Gaston 1986).

Determination of the location of population centres in relation to factors such as habitat distribution and requirements, food availability, population structures, migration systems, and breeding biology of the species concerned remains a pressing need. The manner in which shorebirds depart from the breeding grounds in different areas of the Arctic is little known. Changes in habitat use during and after the breeding season have been studied in Alaska (Connors *et al.* 1979), but little is known of the resources used by shorebirds in the eastern Arctic prior to departure: are the birds dependent on tundra or littoral resources or both?; are there major gathering areas used before an initial flight to staging areas farther south?; do birds accumulate substantial energy reserves, or do they drift south more slowly during the initial stages of migration?

7. Southward migration routes

7.1. North America

Migration routes used by shorebirds within North America may be grouped into three main flyways (Fig. 1). The eastern flyway is used by species that move southwards and southeastwards across the Arctic to staging areas on the northeastern Atlantic coast of Canada and the United States, via the coasts of Hudson Bay and James Bay or across the Ungava Peninsula; some species continue with a direct trans-ocean flight to South America, whereas others move south along the eastern seaboard of North America. Migrants using the central flyway move southwards through the central plains and mountain regions of Canada and the United States and then on to South America; some linger along the US Gulf Coast, in Mexico and in Central America. Western flyway migrants move south from breeding grounds in eastern Siberia and Alaska along the Pacific coast to wintering grounds that stretch from British Columbia to Tierra del Fuego.

7.1.1. Eastern flyway

Some shorebird populations from the eastern Arctic appear to cross the Ungava Peninsula to reach staging areas on the eastern seaboard of North America (Todd 1963). White-rumped Sandpipers are reported to be the most common shorebird along the coast of Labrador (Austin 1932) and apparently migrate farther north and east than most species, being uncommon in the New England states. Larger species, such as the Whimbrel, which are able to use upland habitats found in the region, are also relatively common on this route.

The coastlines of James Bay and Hudson Bay form a migration route of major international importance for many shorebirds breeding in the eastern and central Arctic (Morrison and Harrington 1979; Morrison and Gaston 1986). The most important habitats are found along the west coast of James Bay and south coast of Hudson Bay, between Moosonee, Ontario, and Churchill, Manitoba. These coastlines form the seaward margin of the Hudson Bay Lowlands, which comprise some 324 000 km² of bogs, fens, and muskeg. The very flat topography (gradient 0.5 m·km⁻¹ and moderate tidal ranges (1.2–3.3 m) have produced extensive intertidal flats and marshes, forming a migration corridor some 1600 km long and several kilometres in width. Nearshore salinities are often reduced, particularly in southern James Bay, by fresh water from the major rivers.

Shorebirds are not distributed homogeneously but concentrate heavily in preferred areas, a phenomenon noted throughout their ranges. In southern James Bay, for instance, 71% of the Semipalmated Sandpipers counted occurred in 10% of the coastline surveyed, with the top three sectors holding some 88% of the birds in 18% of the coast (Morrison 1983, 1984). Their distribution appeared to be related to the density of their preferred food, both at a local level and over longer stretches (several hundred kilometres) of coastline (Morrison 1983). Many species use the resources of the coast of James Bay to accumulate fat reserves that will provide the energy for subsequent flights to the major staging areas on the eastern seaboard. Banding studies have demonstrated the dispersal of Semipalmated Sandpipers to east coast estuaries, particularly the upper Bay of Fundy, and thence to wintering areas on the north coast of South America (Morrison 1984). Dunlin undergo a full post-

nuptial moult while on the coast of James Bay. Most of the central Arctic population of Red Knot probably uses the coast of James Bay, and Hudsonian Godwits appear to accumulate enough energy reserves during their stay in James Bay for a direct flight to South America (Hagar 1966; Morrison and Harrington 1979; Morrison 1984).

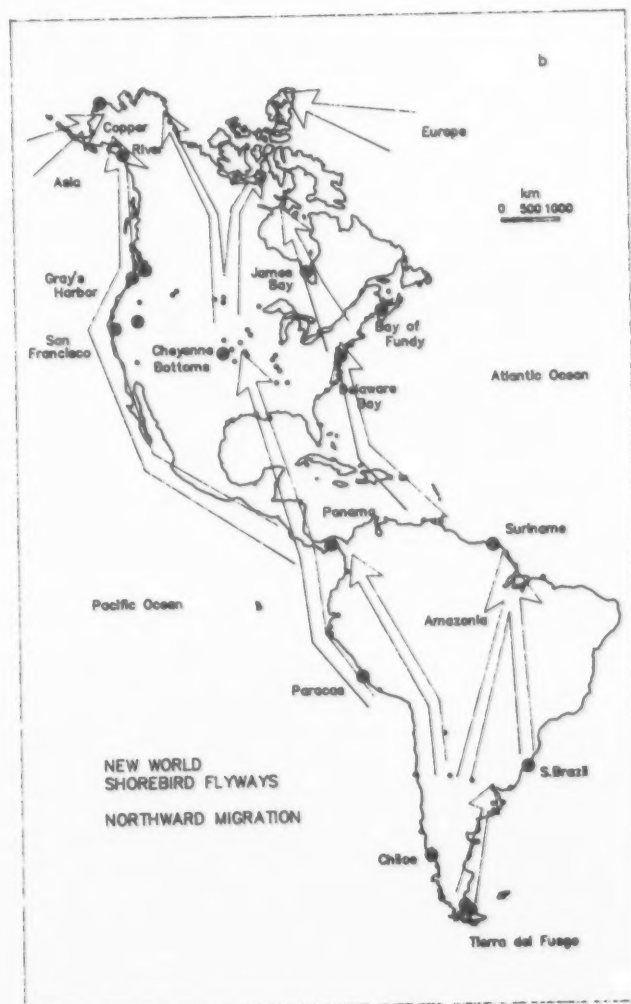
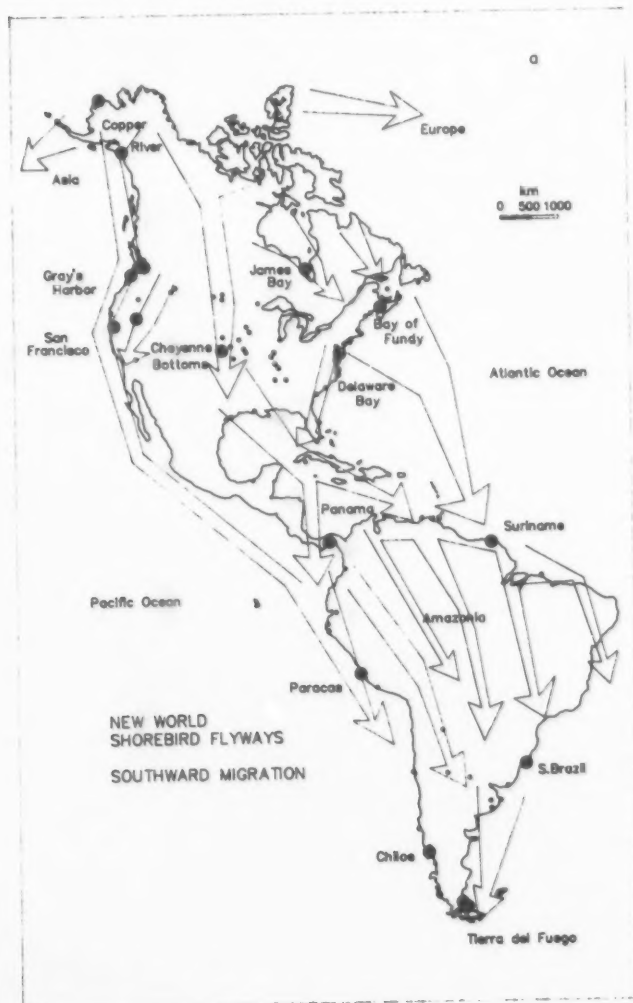
East coast estuaries also serve as critically important staging areas where shorebirds put on fat reserves to fuel the next stage of their migration, which takes many species on a direct, trans-ocean flight to South America. The upper Bay of Fundy is the most important area for Semipalmated Sandpipers, with individual sites, such as Mary's Point, New Brunswick, supporting peak numbers of several hundred thousand birds every year. Major staging areas differ for other species. Red Knot, for example, concentrate

at a restricted number of sites in Massachusetts and New Jersey. For many species, the top five sites support 50% or more of the populations concerned (Manomet Bird Observatory 1986).

7.1.2. Interior flyway

Other species or populations use interior flyways. Baird's Sandpiper migrates through the central High Plains of North America; Jehl (1979) concluded that it departed from such central staging areas on a nonstop flight of some 6500 km to the Andes in northern South America. Semipalmated Sandpipers from the western parts of the breeding range appear to migrate south along a central route (Harrington and Morrison 1979); some move on to wintering areas on the north coast of South America

Figure 1
Shorebird flyways in the New World: (a) southward migration; (b) northward migration. Arrows show some of the principal flyways along which shorebirds move during their migrations between breeding areas in the Arctic and sub-Arctic and wintering areas in South America. Filled circles show locations of sites that support substantial numbers of shorebirds and that have been nominated for inclusion in the Western Hemisphere Shorebird Reserve Network (Morrison and Myers 1987; Myers *et al.* 1987a, 1987b). Large circles indicate sites of "hemispheric" importance, supporting over 250 000 shorebirds or 30% or more of a species' flyway population, and small circles indicate "regional" sites, which support 20 000 shorebirds or 5% or more of a species' flyway population.



(Lank 1979, 1983), whereas others cross to the Pacific side, perhaps through Panama, to winter along the Pacific coast. Many Sanderlings, both those flying southwards along the Atlantic coast and those moving through the interior of North America, travel to wintering areas along the Pacific coast of South America in Peru and Chile (Myers *et al.* 1984). Some Western Sandpipers from breeding grounds on the north slope of Alaska migrate through the interior (Senner and Martinez 1982).

Saline lakes scattered across the Great Basin of the United States are extremely important stopover points for phalaropes. Tens to hundreds of thousands, perhaps more, of Red-necked Phalaropes and Wilson's Phalaropes have been reported from Great Salt Lake, Utah, Mono Lake, California, and Abert Lake, Oregon (Senner and Howe 1984; Jehl 1986), and further investigations are likely to result in the discovery of other important staging areas.

7.1.3. Pacific flyway

Western Sandpipers and Dunlins (of the race *C. alpina pacifica*) breeding in western Alaska migrate principally along the Pacific coast, making use of a series of estuaries, including the lower Fraser River delta and Chesterman Beach/Tofino mudflats in British Columbia (Butler and Kaiser 1988), the Gray's Harbor area in Washington, and San Francisco Bay, California, where very large concentrations occur on migration. The Wandering Tattler and Surf-bird also migrate along the Pacific coast.

Although the general pattern of shorebird migration in North America may be usefully summarized in terms of the three flyways described above, such a categorization oversimplifies the movements and behaviour of particular species or populations, and of individual birds. For instance, Western Sandpipers from Alaskan breeding grounds move south through both the Pacific and Interior flyways (Senner and Martinez 1982), and Sanderlings bound for the Pacific coasts of Chile and Peru have been observed on the northeast coast of the United States as well as in the interior (Myers *et al.* 1984). One individual Sanderling was observed during the same migration in Massachusetts and subsequently in Texas (J.P. Myers, unpubl. data; Morrison and Myers 1987).

7.2. South America

Migration routes in South America are less well documented than those in North America. Many shorebirds arriving on the north coast of South America after a direct flight from the eastern seaboard of North America, or from an interior staging site, move eastwards along the north coast of the continent before reaching their wintering area or before heading farther south (Spaans 1978). Antas (1983) reviewed possible migration routes of shorebirds in Brazil. Many shorebirds must use different routes during southward and northward migrations, because the interior wetlands are available only during the time when they are travelling south. In the Pantanal, for instance, water levels are low from August to October, and some 250 000 km² of mudflats, sandflats, small lagoons, and wet grasslands mixed with belts of forest are available. After the rainy season, lasting from October to March, much of the area is inundated and offers little or no suitable habitat for shorebirds. Little is known of the extent to which this or other major interior wetland systems are used during these migrations, although few Nearctic shorebirds were found during aerial surveys of the Araguaia River/Bananal Island

region in September 1987 (R.I.G. Morrison and R.K. Ross, unpubl. data).

An important migration route used by species such as Baird's Sandpiper and Wilson's Phalarope involves the series of high lakes in the Andes mountains, leading southwards along the mountain chain to inland lakes and wetlands, such as the Laguna Mar Chiquita in Argentina. Little information is available on this flyway.

On the Pacific coast, estuaries — including Buenaventura Bay/southern Colombia, the Gulf of Guayaquil, Ecuador, and the Virrila estuary in northern Peru — as well as isolated patches of habitat — e.g., at Paracas, Peru, and coastal lagoon complexes, such as those at Mejia, Peru — provide stopover areas for shorebirds during southward migration.

8. Wintering areas

8.1. North America

A general guide to where shorebirds occur in midwinter in the United States and temperate Canada may be obtained from the Christmas Bird Counts organized by the National Audubon Society. Such counts, however, do not provide solid quantitative information because of the wide variation in effort and lack of standardization for censuses in tidal areas. More-quantitative studies have generally been limited to a particular geographical region (e.g., the California Shorebird Survey, Jurek 1974) or to particular species (e.g., Piping Plover, Haig and Oring 1985, 1987; Sanderling, Myers *et al.* 1985; Snowy Plover, Page *et al.* 1986).

Such surveys have revealed large concentrations of shorebirds along the Pacific coast of the United States, especially in coastal and estuarine habitats in the vicinity of San Francisco Bay, where the most diverse community of wintering shorebirds in North America is found. The mild winter climate and rich mosaic of shorebird habitats in northern California are presumably responsible for the presence of such large numbers of birds.

Estuaries to the north of northern California, although important for individual species, support less diverse communities of shorebirds. Short- and Long-billed dowitchers, Willets, Semipalmated Plovers, and Marbled Godwits make little use of estuaries in northern Washington, although these sites harbour many thousands of Dunlins (Widrig 1980; Buchanan *et al.* 1986), and during some winters numbers of Sanderlings in western Washington are the highest in North America (C.T. Schick and J.P. Myers, unpubl. data).

South of central California, numbers again fall steadily to Baja California (Schick *et al.* 1984). Many of the coastal lagoons and estuaries that might once have supported large numbers of shorebirds in southern California have disappeared through land reclamation.

Relatively few shorebirds winter on the east coast of the United States compared with the Pacific side. North of Virginia, the Dunlin is virtually the only species with wintering totals exceeding the low thousands. Numbers of other species increase south of Cape Hatteras; in Florida (especially along the south and Gulf coasts), estuaries and marshes are found that support tens of thousands (totalled across all species) of Dunlins, Red Knots, Western Sandpipers, Black-bellied Plovers, Semipalmated Plovers, and other species (Below 1985). The Gulf coast of Florida is particularly important for some 10 000 Red Knots

(Harrington *et al.* 1988), which form a distinct population well separated geographically from the main wintering group in Patagonia (Morrison 1984).

Vast marshes and tidal flats in coastal Alabama, Mississippi, Louisiana, and Texas could harbour large numbers of shorebirds. Midwinter counts, however, are available from only a small number of the potential sites, mostly around urban centres. Numbers reported from such areas indicate that the coastline may be of major significance to species preferring marsh habitats, such as yellowlegs and Least Sandpipers. Sandy beaches around the coast of the Gulf of Mexico are important for the endangered Piping Plover (Haig 1987).

Little quantitative information is available from the Mexican section of the Gulf coast, work there having been directed specifically towards Piping Plovers (Haig 1987) and Sanderlings (Myers *et al.* 1984).

8.2. Central America

The only area in Central America for which quantitative information is available is Panama. Recent aerial surveys under the Canadian Wildlife Service Latin American Program indicate that the Gulf of Panama is of major international importance for Western Sandpipers, and that the area also holds substantial wintering populations of dowitchers, Willets, and Whimbrels (R.I.G. Morrison and R.K. Ross, unpubl. data). The area may also be important for Semipalmated Plovers, and one flock of 10 000 Wilson's Plovers was observed in Panama in December 1986 (Morrison and Myers 1987).

8.3. South America

Identification of the major wintering areas used by different species and groups of shorebirds on the coast of South America has come from the Canadian Wildlife Service Shorebird Atlas Project. Low-level aerial surveys carried out between 1981 and 1986 covered some 28 000 km of coastline and included all sectors of coast thought to contain important shorebird habitat. Some 2.92 million shorebirds were counted during the surveys. Most species were highly concentrated into their preferred areas (Morrison and Ross 1989). The total numbers of shorebirds counted during the surveys are summarized in Table 1, and the distribution patterns, grouped by size category, in Figure 2. Myers and associates also carried out ground-based work along the Pacific coast of South America.

The principal wintering area for Semipalmated Sandpipers, which made up the bulk of the 2 million small sandpipers found on the north coast, was in the Guianas: 65% were found in Suriname, with a further 19% in French Guiana, so that these two small countries held nearly 84% of the total. The north-central coast of Brazil was also important, with 9% of the total (Morrison and Ross 1989).

The most important coastal wintering areas for Red Knot were in Tierra del Fuego. Some 55% of the South American total of 76 000 knots occurred on the vast intertidal flats of Bahía Lomas, near the eastern mouth of the Strait of Magellan in the Chilean sector of Tierra del Fuego. Knots were also found along the Atlantic coast of Argentinian Tierra del Fuego, with concentrations in Bahía San Sebastian and near Rio Grande. Altogether, Tierra del Fuego held 70% of the South American total, with the remainder wintering on the eastern Atlantic coast between Tierra del Fuego and the Rio Colorado in Argentina.

Two centres of distribution of Hudsonian Godwits were evident. The single most important site was Bahía San Sebastian on the Atlantic coast of Tierra del Fuego in Argentina, where 43% of the South American total of 46 000 were found. With other areas, particularly Bahía Lomas (23%), Tierra del Fuego held 69% of the South American total. The second major centre, the Chiloe area in southern Chile, held 28% of the total.

Most (88%) of the 112 000 Sanderlings counted in South America occurred along the ocean beaches of the Pacific coast, with major concentrations occurring in northern Peru around Pacasmayo and on the huge ocean beach fronting the Sechura Desert; moderate to large numbers occurred south to Chiloe.

The north-central coast of Brazil between Belem and Sao Luis was of particular importance for Ruddy Turnstones, Black-bellied Plovers, Willets, and Whimbrels (76, 54, 49, and 44% of the South American species totals, respectively).

On the eastern (Atlantic) coast, important habitats were found in Rio Grande do Sul in southern Brazil, including both ocean beaches and nearshore, shallow, saline to brackish lagoons. The Lagoa do Peixe is the most important area currently known, holding substantial numbers of small sandpipers, mostly White-rumped Sandpipers, and Lesser Golden-Plovers. Coastal lagoons in Uruguay were also important for shorebirds, with the Laguna da Rocha supporting large numbers of Lesser Golden-Plovers (Morrison and Ross 1989).

On the Pacific side, shorebird habitats other than ocean beaches were often restricted in area and separated by long distances, and they assumed considerable importance both as wintering areas and as staging sites. In Peru, such habitats included isolated wetlands or lagoon systems, such as those at Mejia, the tidal flats at Paracas and nearby river mouth habitats associated with the Pisco River, and the extensive Virrila estuary in the north of the country.

Other studies have highlighted the importance of central and northern Argentina for wintering shorebirds, especially along the coast of Buenos Aires province. Considerable numbers of White-rumped Sandpipers and Pectoral Sandpipers are found in the coastal marshes, whereas Lesser Golden-Plovers and Buff-breasted Sandpipers inhabit upland areas (Wetmore 1926, 1927; Myers and Myers 1979). Although these studies do not provide estimates of total populations, they clearly identify some of the richest nontidal shorebird habitats yet found in South America.

The totals shown in Table 1 represent minimum population figures for shorebirds on wintering areas in coastal South America. Ground-truthing operations to determine accuracy of counts were not undertaken, being largely impracticable because of the very remote coastlines and large distances involved; it is also doubtful whether appropriate correction factors could be developed that would be applicable to all of the extremely wide variety of conditions encountered during the surveys. The survey totals of 2.08 million small sandpipers for the north coast may be compared with Spaans' (1984) estimate of 2 to 5 million using the coast of Suriname at peak periods, and of some 76 000 Red Knots with Harrington *et al.*'s (1988) estimate of 100 000 for this species (revised from 150 000+; Harrington 1982).

Table 1

Totals of Nearctic shorebirds counted during aerial surveys of coastal wintering areas in South America in January/February between 1981 and 1986 during the Canadian Wildlife Service Shorebird Atlas Project (from Morrison and Ross 1989)

(a) Small shorebirds*

Country	Small shorebirds	Sanderling	Total small shorebirds
Venezuela	93 822	654	94 476
Trinidad	12 388	5	12 393
Guyana	9 778	30	9 808
Suriname	1 346 583	42	1 346 625
French Guiana	394 332	2	394 334
Brazil	241 830	10 982	252 812
Uruguay	3 132	5	3 137
Argentina	39 580	1 849	41 429
Chile	20 899	30 287	51 186
Peru	22 829	66 846	89 675
Ecuador	2 044	230	2 274
Colombia	28 790	883	29 673
Total	2 216 007	111 815	2 327 822

(b) Medium-sized shorebirds

Country	Medium-sized shorebirds	Lesser Golden-Plover	Black-bellied Plover	Ruddy Turnstone	Surf-bird	Yellowlegs species	Red Knot	Dowitcher species	Total medium-sized shorebirds
Venezuela	18 699	0	403	261	0	2 377	520	10 213	32 473
Trinidad	80	0	173	6	0	518	0	209	986
Guyana	1 248	0	598	48	0	6 824	0	2 900	11 618
Suriname	55 392	0	3 940	619	0	66 377	0	21 840	148 168
French Guiana	24 148	0	640	601	0	5 117	0	2 400	32 906
Brazil	50 242	758	17 024	18 859	0	6 734	8 326	8 310	110 258
Uruguay	3 087	3 167	365	253	0	88	0	0	6 960
Argentina	4 250	115	10	321	0	715	24 784	0	30 195
Chile	1 133	15	28	150	120	224	42 762	0	44 432
Peru	18 035	0	1 344	1 908	77	1 899	0	0	23 367
Ecuador	1 334	0	1 082	109	0	135	0	825	3 485
Colombia	8 012	0	1 660	364	0	39	0	2 162	12 238
Total	185 660	4 055	27 267	23 499	197	91 047	76 392	48 839	457 086

(c) Large shorebirds

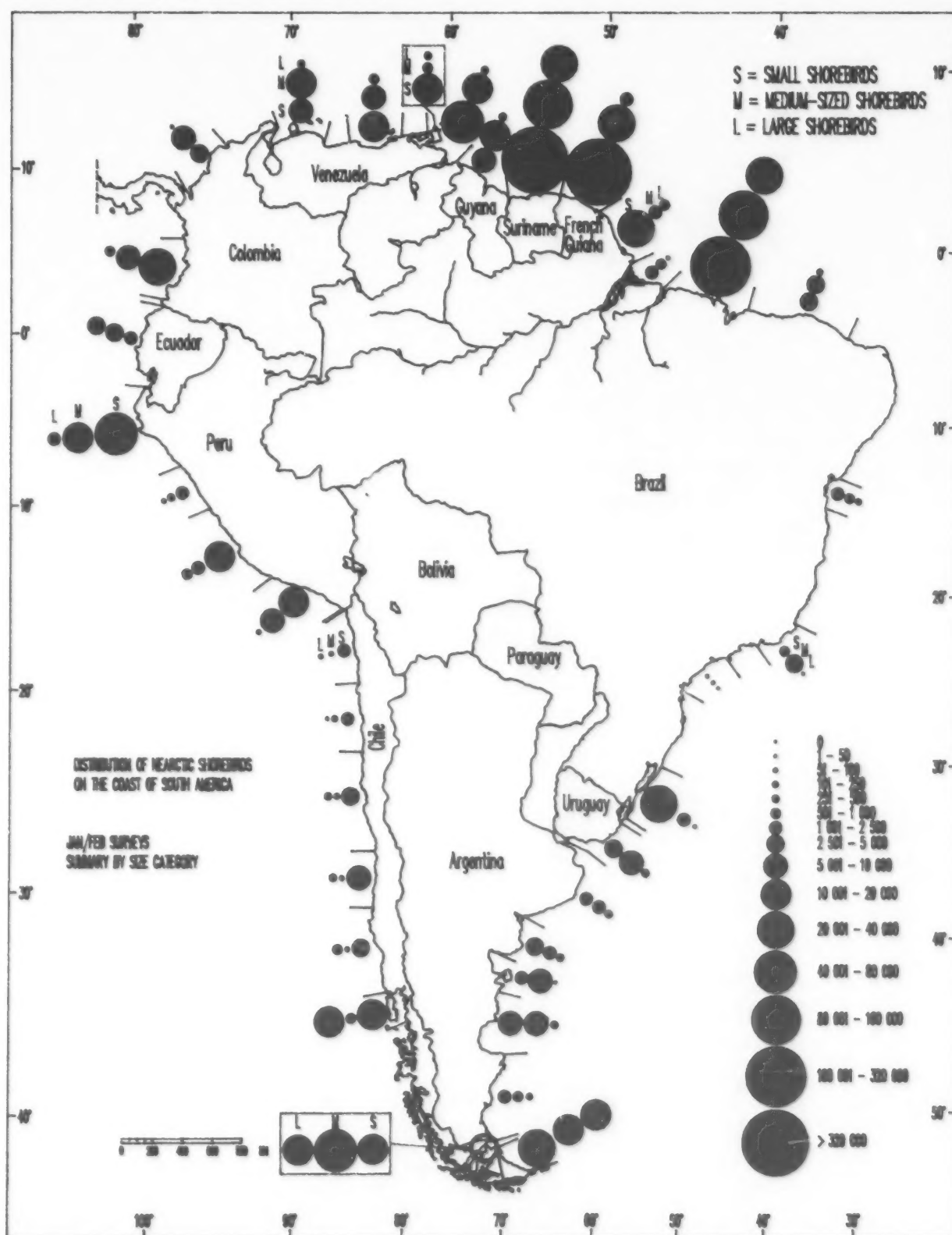
Country	Large shorebirds	Whimbrel	Willet	Hudsonian Godwit	Total large shorebirds
Venezuela	221	326	858	0	1 405
Trinidad	0	75	184	0	259
Guyana	0	57	283	0	340
Suriname	2 580	3 310	15 646	0	21 536
French Guiana	1 039	326	729	0	2 094
Brazil	1 939	11 203	21 996	4	35 147
Uruguay	94	2	0	326	422
Argentina	60	20	0	20 726	20 806
Chile	4	7 711	2	24 302	32 019
Peru	542	933	588	171	2 234
Ecuador	60	562	3 384	0	4 006
Colombia	0	349	700	0	1 049
Total	6 539	24 874	44 370	45 529	121 317

(d) Summary by size category

Country	Length (km)	Total small shorebirds	Total medium-sized shorebirds	Total large shorebirds	Total unclassified shorebirds	Total
Venezuela	1 939	94 476	32 473	1 405	1 411	129 765
Trinidad	484	12 393	986	259	0	13 638
Guyana	479	9 808	11 618	340	0	21 766
Suriname	370	1 346 625	148 168	21 536	10 000	1 526 329
French Guiana	388	394 334	32 906	2 094	1 500	430 834
Brazil	7 852	252 812	110 258	35 147	0	398 217
Uruguay	624	3 137	6 960	422	0	10 519
Argentina	4 548	41 429	30 195	20 806	194	92 624
Chile	5 488	51 186	44 432	32 019	0	127 637
Peru	2 775	89 675	23 367	2 234	0	115 276
Ecuador	1 385	2 274	3 485	4 006	0	9 765
Colombia	1 601	29 673	12 238	1 049	0	42 960
Total	27 933	2 327 822	457 086	121 317	13 105	2 919 330

*For species in each size category, see Morrison *et al.* (1985).

Figure 2
Summary by size category of the distribution of Nearctic shorebirds on the coast of South America observed during surveys conducted in January/February from 1981 to 1986 (for species in each size category, see Morrison and Ross 1989).



9. Northward migration

As on southward migration, birds travelling north to the breeding grounds often concentrate at a discrete series of stopover areas, where large proportions of the population occur.

9.1. South America

Red Knots are found in large numbers on the Valdes Peninsula on the coast of Argentina as they move northwards from Tierra del Fuego and Patagonia. The lagoons and coastline of southern Brazil, and probably northern Uruguay, make up the next important staging area for both Red Knots and Hudsonian Godwits, with concentrations of up to 11 000 and 3000+, respectively, reported from the Lagoa do Peixe. The birds are very heavy, implying that they are about to make a long flight, which presumably takes them across Amazonia to at least the north coast of South America (unpubl. data; Harrington *et al.* 1986). Colour-marked Red Knot from the Lagoa do Peixe were observed on the north-central coast of Brazil during aerial surveys in May 1987 (R.I.G. Morrison, R.K. Ross, and P.T.Z. Antas, unpubl. data).

On the Pacific coast, enormous numbers of shorebirds, particularly Sanderlings, have been reported from areas such as the Paracas Peninsula, Peru, during northward migration (M. Plenge, pers. commun.).

9.2. North America

International Shorebird Survey counts from central and eastern areas of the United States have shown that migrants concentrate even more heavily during northward migration than during the autumn. For 13 out of 20 species of shorebirds censused, more than 75% of the birds were at only five or fewer sites, and at just one site in the case of six species. The most spectacular concentrations on the Atlantic coast occur in Delaware Bay, where migration appears to be timed to coincide with the peak of egg laying by horseshoe crabs *Limulus polyphemus* (Myers 1986). The shores of Delaware Bay have been estimated to support 80% of the Ruddy Turnstones, 79% of Red Knots, 70% of Semipalmated Sandpipers, and 62% of the Sanderling counted during spring migration in the United States (Manomet Bird Observatory 1986).

From Delaware Bay, many birds strike inland toward Arctic breeding grounds. Flyways along the coasts of James Bay and Hudson Bay are used by many species, particularly Dunlins, Red Knots, and Semipalmated Sandpipers (R.I.G. Morrison, unpubl. data).

ISS results also imply that shorebirds are highly concentrated at inland staging sites. Cheyenne Bottoms, Kansas, supported over 90% of White-rumped Sandpipers, Baird's Sandpipers, Stilt Sandpipers, Long-billed Dowitchers, and Wilson's Phalaropes, over 70% of Pectoral Sandpipers and Marbled Godwits, and nearly 60% of the Hudsonian Godwits counted on the surveys (Manomet Bird Observatory 1986). Although discovery and coverage of other areas may alter these figures, it seems clear that substantial proportions of birds are found at a very limited number of locations. Cheyenne Bottoms (45%) and Delaware Bay (31%) together accounted for 76% of the shorebirds counted at 210 sites during spring migration (Manomet Bird Observatory 1986).

Interior sites serve as stopover points for birds coming from many different parts of the wintering range.

Morphometric studies have demonstrated that many Semipalmated Sandpipers that breed in the central part of the Arctic and winter along the north coast of South America migrate northwards through interior sites such as Cheyenne Bottoms and return southwards via the eastern seaboard of North America (Harrington and Morrison 1979). White-rumped Sandpipers, which winter much farther south, also appear to take a central route northwards, returning in the autumn via the northeastern seaboard of North America, as shown by both counts and band recoveries (Morrison 1984). Baird's Sandpipers, although wintering at southern latitudes comparable with those of White-rumped Sandpipers, migrate in both directions along the Andes in South America and via a central route in North America (Jehl 1979). Some Sanderlings wintering on the Pacific coast cross the central American isthmus and migrate northwards through the interior, returning to the Pacific coast either via the east coast or by a central route. Individual Sanderlings have been observed northbound on the Pacific coast of Oregon and southbound on the Atlantic coast, thus describing a vast circumcontinental route (Myers *et al.* 1984).

Recent surveys indicate that large numbers of shorebirds pass northwards through the Canadian Prairies; especially significant concentrations of Sanderlings (estimated to be up to 50% of the South American wintering population) occurred at Old Wives Lake and Chaplin Lake in late May 1987 (Dickson and Smith 1988).

Major concentration areas also occur on the west coast. San Francisco Bay and Humboldt Bay in California both support over 100 000 shorebirds at one time, and over 1 million pass through Gray's Harbor, Washington, en route northwards (Senner and Howe 1984). Major staging areas for Sanderlings occur in the Oregon Dunes National Recreation Area and on the beaches from northern Oregon to Gray's Harbor, with an estimated 30 000+ Sanderling passing through these areas (Myers *et al.* 1985). In Alaska, the Copper River delta supports well over a million shorebirds during spring migration, some estimates running as high as 20 million (Isleib 1979). The bulk of the entire world population of Western Sandpipers and Dunlin of the subspecies *C. alpina pacifica* passes through the Copper River delta (Senner *et al.* 1981; Senner and Howe 1984).

10. Conservation initiatives

The wide geographical perspective provided by the international survey operations, such as the South American Shorebird Atlas Project, the ISS, and the Pan American Shorebird Program, has led directly to the formulation of new conservation initiatives. The demonstration that large proportions of shorebird populations are often dependent on a limited number of key sites both on the wintering grounds and during migration implies that, for conservation to be ultimately successful, all the key areas must be protected, as removal of any one of the critical links in the chain would put the entire migration system at risk. The concept thus soon emerged of creating a system of linked reserves that would protect the key sites used by the birds throughout the year (Morrison 1983, 1984), and the result has been the setting up of a Western Hemisphere Shorebird Reserve Network with this objective, as described by Myers *et al.* (1987a, 1987b).

11. Gaps in knowledge

Although recent research has clarified many aspects of shorebird flyways in the New World, much information is still required for the formulation of soundly based conservation and management initiatives. Some of the main areas in which further information is required may be summarized as follows:

- (1) Much better information is needed on the locations of the main population centres on the breeding grounds. Better information is needed on breeding densities, in relation to habitat, food supply, and other birds, and on year-to-year variability in densities, breeding success, and productivity. More information is also required from Arctic (particularly the eastern Arctic) and sub-Arctic areas on the location of gathering points and the resources used by the birds before their departure from the breeding grounds.
- (2) On the Pacific coast, little information is available on species such as the Wandering Tattler and Surf-bird. Better information is needed on the numbers and phenology of shorebirds using west coast estuaries.
- (3) Another major gap concerns knowledge of staging areas in the interior of North America, particularly on the Canadian Prairies, in the US west and midwest, and on the lakes of the Great Basin. Recent work on the Canadian Prairies has begun to fill this gap (Dickson and Smith 1988; Colwell *et al.* 1988; ISS, unpubl. data).
- (4) In South America, much more information is needed on numbers and phenology of birds using staging areas on the coast and wetland areas in the interior. Although information has recently been brought together on the location and characteristics of the major Neotropical wetlands (Scott and Carbonell 1986), little is known about their use by shorebirds at any time of the year. Very little information is available from potential inland stopover areas in the interior of Brazil or along the Andes chain. Another region for which much better information is required includes Mexico, Central America, and the Caribbean.
- (5) Relatively little information is available on species associated with upland habitats, such as the Lesser Golden-Plover, the Buff-breasted Sandpiper, and the Upland Sandpiper. Another group of species for which more information is required includes those breeding within South America, such as the Magellanic Plover.
- (6) More information is needed on shorebirds remaining in South America and south of the breeding grounds during the breeding season, and the importance of "summering areas" to subadult portions of the population.
- (7) Better information is needed on population trends in shorebird populations in the New World and on the factors affecting their productivity and survival. Information on how mortality is divided between the various phases of the annual cycle and when shorebirds are most vulnerable to environmental pressures is also needed.

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Appendix 1

Scientific names of shorebird species mentioned in the text

Common name	Scientific name
Black-bellied Plover	<i>Pluvialis squatarola</i>
Lesser Golden-Plover	<i>Pluvialis dominica</i>
Snowy Plover	<i>Charadrius alexandrinus</i>
Wilson's Plover	<i>Charadrius wilsonia</i>
Semipalmated Plover	<i>Charadrius semipalmatus</i>
Piping Plover	<i>Charadrius melodus</i>
Magellanic Plover	<i>Pluvianellus socialis</i>
Yellowlegs sp.	<i>Tringa melanoleuca/T. flavipes</i>
Willet	<i>Catoptrophorus semipalmatus</i>
Wandering Tattler	<i>Heteroscelus incanus</i>
Upland Sandpiper	<i>Bartramia longicauda</i>
Whimbrel	<i>Numenius phaeopus</i>
Hudsonian Godwit	<i>Limosa haemastica</i>
Marbled Godwit	<i>Limosa fedoa</i>
Ruddy Turnstone/Turnstone	<i>Arenaria interpres</i>
Surfbird	<i>Aphriza virgata</i>
Red Knot/Knot	<i>Calidris canutus</i>
Sanderling	<i>Calidris alba</i>
Semipalmated Sandpiper	<i>Calidris pusilla</i>
Western Sandpiper	<i>Calidris mauri</i>
Least Sandpiper	<i>Calidris minutilla</i>
White-rumped Sandpiper	<i>Calidris fuscicollis</i>
Baird's Sandpiper	<i>Calidris bairdii</i>
Pectoral Sandpiper	<i>Calidris melanotos</i>
Dunlin	<i>Calidris alpina</i>
Stilt Sandpiper	<i>Micropalama himantopus</i>
Short-billed Dowitcher	<i>Limnodromus griseus</i>
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>
Buff-breasted Sandpiper	<i>Tryngites subruficollis</i>
Wilson's Phalarope	<i>Phalaropus tricolor</i>
Red-necked Phalarope	<i>Phalaropus lobatus</i>

Part 2

Recommendations of the Conference



**CONVENTION ON WETLANDS OF
INTERNATIONAL IMPORTANCE ESPECIALLY AS
WATERFOWL HABITAT**

Third Meeting of the Conference of the Contracting Parties
27 May to 5 June 1987
Regina, Saskatchewan, Canada

**Recommendation 3.1:
Criteria for identifying wetlands of
international importance and
guidelines on their use**

TAKING NOTE of the deliberations and conclusions of the Workshops on Criteria and on Flyways held at the present Meeting;

RECOGNIZING the concerns of the developing countries that further examination of the criteria and guidelines for identifying wetlands of international importance, and of application of the wise use provisions of the Convention, may be desirable;

**THE CONFERENCE OF THE CONTRACTING
PARTIES**

RECOMMENDS that the Criteria for identifying wetlands of international importance, as revised at Regina and included in the Annex to the Regina Recommendations, be used for identification of wetlands to be designated for the List under Article 2 of the Convention;

FURTHER RECOMMENDS that a working group shall be established in order to examine the ways in which the criteria and guidelines for identifying wetlands of international importance might be elaborated, and the wise use provisions of the Convention applied, in order to improve the worldwide application of the Convention; and

FINALLY RECOMMENDS that the members of the working group shall be agreed by the Standing Committee of the Conference of the Contracting Parties, that the working group shall select its own Chairman, that the Convention Bureau shall act as coordinator of the group, that the working group may consult with appropriate technical advisors and shall report its findings to the Bureau within 18 months for circulation to the Contracting Parties and observers for comment, that the Convention Bureau shall prepare a report based on comments received and a draft recommendation for consideration by the next ordinary Meeting of the Conference of the Contracting Parties, both of which shall be circulated to Contracting Parties and observers no later than 12 months before the next ordinary Meeting of the Conference of the Contracting Parties.

**Recommendation 3.2:
Need for further studies of flyways**

RECALLING that the Conference of the Contracting Parties is competent to consider "reports and statistics on matters which are essentially international in character affecting wetlands";

NOTING that Contracting Parties to the Convention on Wetlands of International Importance especially as Waterfowl Habitat establish "nature reserves on wetlands, whether they are included in the List or not";

TAKING NOTE of the conclusions of the Workshop on Flyways and Reserve Networks at the present Meeting;

**THE CONFERENCE OF THE CONTRACTING
PARTIES**

RECOMMENDS that research be undertaken urgently to investigate the recent and severe decline in numbers of waders (shorebirds) in the Western Hemisphere;

FURTHER RECOMMENDS that research on waders (shorebirds) be pursued in West Africa and at inland sites used by waders, with a view to determining population trends and migration routes;

FURTHER RECOMMENDS that research efforts be intensified in East Asia to discover the cause of the severe decline in populations of ducks and large water birds;

FURTHER RECOMMENDS that waterfowl hunting statistics be collected, to allow better management of flyway populations of waterfowl, in particular in the Western Palearctic region (and especially the Mediterranean) and in East Asia;

EMPHASIZES the urgent need for information on wader (shorebird) populations using the East Africa flyway; and

EMPHASIZES the need to establish reserves at wetlands linked by migratory birds as already begun in the Western Hemisphere.

Recommendation 3.3: Wise use of wetlands

RECALLING that Contracting Parties to the Convention on Wetlands of International Importance especially as Waterfowl Habitat "formulate and implement their planning so as to promote . . . the wise use of wetlands in their territory";

EMPHASIZING the need to develop a definition of wise use, in order to guide Contracting Parties in their implementation of the Convention;

NOTING that Recommendations 1.5 of the First Meeting and 2.3 of the Second Meeting of the Conference of the Contracting Parties referred to the need for national wetland policies in order to promote wise use;

TAKING NOTE of the deliberations and conclusions of the Workshop on Wise Use at the present Meeting;

THE CONFERENCE OF THE CONTRACTING PARTIES

RECOMMENDS that the Contracting Parties adopt the definition of wise use established by the Conference of the Contracting Parties at its Third Meeting, held at Regina, and included in the Annex to the Regina Recommendations;

FURTHER RECOMMENDS that the Contracting Parties give particular attention to the wise use of wetlands by promotion of wetland policies containing elements (a) to (f) from the first part of the Guidelines on wise use included in the Annex to the Regina Recommendations; and

FURTHER RECOMMENDS that, while detailed policies are being established, immediate action be taken to stimulate wise use, including actions (a) to (d) from the second part of the Guidelines on wise use included in the Annex to the Regina Recommendations.

Annex to the Regina Recommendations

CRITERIA FOR IDENTIFYING WETLANDS OF INTERNATIONAL IMPORTANCE FOR DESIGNATION FOR THE LIST UNDER ARTICLE 2 OF THE RAMSAR CONVENTION

as revised at the Third Meeting of the Conference of the Contracting Parties in Regina

A wetland is suitable for inclusion in the List if it meets any one of the criteria set out below:

1. Criteria for assessing the value of representative or unique wetlands.

A wetland should be considered internationally important if it is a particularly good example of a specific type of wetland characteristic of its region.

2. General criteria for using plants or animals to identify wetlands of importance.

A wetland should be considered internationally important if:

- (a) it supports an appreciable assemblage of rare, vulnerable, or endangered species or subspecies of plant or animal, or an appreciable number of individuals of any one or more of these species; or
- (b) it is of special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its flora and fauna; or
- (c) it is of special value as the habitat of plants or animals at a critical stage of their biological cycles; or
- (d) it is of special value for its endemic plant or animal species or communities.

3. Specific criteria for using waterfowl to identify wetlands of importance.

A wetland should be considered internationally important if:

- (a) it regularly supports 20 000 waterfowl; or
- (b) it regularly supports substantial numbers of individuals from particular groups of waterfowl, indicative of wetland values, productivity, or diversity; or
- (c) where data on populations are available, it regularly supports 1% of the individuals in a population of one species or subspecies of waterfowl.

Guidelines

A wetland could be considered for selection under Criterion 1 if:

- (a) it is an example of a type rare or unusual in the appropriate biogeographical region; or
- (b) it is a particularly good representative example of a wetland characteristic of the appropriate region; or
- (c) it is a particularly good representative of a common type where the site also qualifies for consideration under criteria 2a, 2b, or 2c; or
- (d) it is representative of a type by virtue of being part of a complex of high-quality wetland habitats. A wetland of national value could be considered of international importance if it has a substantial hydrological, biological, or ecological role in the functioning of an international river basin or coastal system; or
- (e) in developing countries, it is a wetland which, because of its outstanding hydrological, biological, or ecological role, is of substantial socioeconomic and cultural value within the framework of sustainable use and habitat conservation.

INFORMATION ON WISE USE OF WETLANDS SPECIFIED UNDER ARTICLE 3 OF THE RAMSAR CONVENTION

Definition of wise use

"The wise use of wetlands is their sustainable utilization for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem."

Sustainable utilization is defined as "human use of a wetland so that it may yield the greatest continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations."

Natural properties of the ecosystem are defined as "those physical, biological, or chemical components, such as soil, water, plants, animals, and nutrients, and the interactions between them."

Guidelines

Wise use involves the promotion of wetland policies containing the following elements:

- (a) a national inventory of wetlands;
- (b) identification of the benefits and values of these wetlands;
- (c) definition of the priorities for each site in accordance with the needs of, and socioeconomic conditions in, each country;

- (d) proper assessment of environmental impact before development projects are approved, continuing evaluation during the execution of projects, and full implementation of environmental conservation measures which take full account of the recommendations of this process of environmental assessment and evaluation;
- (e) use of development funds for projects which permit conservation and sustainable utilization of wetland resources;
- (f) regulated utilization of wild fauna and flora, such that these components of the wetland systems are not overexploited.

When detailed policies are being established, action should be taken on:

- (a) interchange of experience and information between countries seeking to elaborate national wetland policies;
- (b) training of appropriate staff in the disciplines which will assist in the elaboration of such policies;
- (c) pursuit of legislation and policies which will stimulate wetland conservation action, including the amendment as appropriate of existing legislation;
- (d) review of traditional techniques of sustainable wetland use, and elaboration of pilot projects which demonstrate wise use of representative national and regional wetland types.

Part 3

*Summary reports of Workshops
A, C, and D*



CONVENTION ON WETLANDS OF
INTERNATIONAL IMPORTANCE ESPECIALLY AS
WATERFOWL HABITAT

Third Meeting of the Conference of the Contracting Parties
27 May to 5 June 1987
Regina, Saskatchewan, Canada

Agenda item XI: Workshop meetings

**Summary report of Workshop A:
Criteria for identifying wetlands of
international importance**
29 May 1987

The workshop was opened by Mr. Veit Koester, one of the vice-chairmen of the Conference. Dr. E. Maltby (IUCN) was confirmed as Chairman of the workshop and Mr. J.Y. Mondain-Monval (IWRB) as Rapporteur.

PROGRAM

Report on selection criteria for Ramsar sites in Nordic countries. T. Larsson. (Distributed as INF. C.3.6.)

Criteria for identifying important peatland sites in Finland. A. Haapanen. (Distributed as INF. C.3.16.)

Criteria for identifying important wetlands in arid zones. J. Forshaw. (Oral submission only.)

Criteria for identification of wetlands of international importance. T. Dahl.

Development of criteria and guidelines for the identification of sites qualifying for Ramsar designation. Working group of the British Nature Conservancy Council. (Distributed as INF. C.3.7.)

Criteria for identification of wetlands of international importance. The IUCN Wetlands Office. (Distributed as INF. C.3.9.)

Criteria for the selection of Ramsar sites. M. Holland.

Criteria for identifying wetlands important for waterfowl in South America. R. Schlatter. (Written submission only.)

CHAIRMAN'S OPENING REMARKS

The Chairman stressed the importance of this workshop, particularly in relation to the points raised in the overview paper (DOC. C.3.10) concerning the worldwide applicability of existing criteria.

SUMMARY OF COMMUNICATIONS

Following the Chairman's suggestion, all the communications were given first, and then discussions took place.

Communications presented can be separated broadly into two categories. The first group (1-4) dealt with experiences in designating sites of international importance and the problems encountered in several countries. The second group of presentations (5-8) proposed guidelines for application of existing criteria and also new criteria. Authors presented a summary of their work as copies of most of the papers were available.

In general, the authors from northern countries and Australia expressed the view that existing criteria were sufficiently broad and suitable for the designation of sites of international importance.

DISCUSSION

A general discussion, expressing wide-ranging views, took place; much of it concerned issues of using the criteria in developing countries. It was felt that in such countries precise numerical criteria were not appropriate because of the lack of information on numbers and population estimates.

Modified and new criteria

The need for modified or new criteria was also expressed by several speakers. These would serve both to attract new Contracting Parties and also to help developing countries to identify wetlands of international importance using criteria more relevant to the Third World.

The importance of traditional culture and uses by human communities of wetland resources was stressed.

Considerable discussion surrounded the introduction of new socioeconomic criteria. This introduction was in general rejected. However, the workshop emphasized the importance of natural values of wetlands such as fisheries or hydrology.

Papers presented by the British Nature Conservancy Council (NCC) working group (INF. C.3.7) and the IUCN Wetlands Office (INF. C.3.9) were also further discussed. Extensive discussion ranged on the various issues raised. A Drafting Committee was elected to review in detail the debates of the workshop and to make an appropriate report to the Plenary Session. (Constitution of the Committee: Chairman, Rapporteur, Australia, France, Iran, Spain, Uruguay, Zambia, and the Advisor of the US delegation.)

Drafting Committee

Four major options were considered in relation to the existing criteria:

1. No change.
2. Minor amendments
 - a — with guidelines
 - b — without guidelines
3. Major amendments
4. Appointment of a new Working Party or Task Force with terms of reference setting the parameters for further detailed discussion on criteria.

Options 1 and 4 were rejected, and, after discussion, the delegates felt that no major amendments including new criteria were necessary at the present time.

The following recommendations were made:

1. Amendment of Criterion 1 in line with the original amendment proposed by Workshop B (Flyways and Reserve Networks). The group enquired whether a minor amendment involving deletion of the word "regularly" could be made but endorsed the recommendation for further guidelines interpreting this criterion.
2. The reordering of the criteria also proposed by Workshop B was agreed upon. The new order of criteria and specific changes to Criterion 3 would read:

CRITERIA FOR IDENTIFYING WETLANDS OF INTERNATIONAL IMPORTANCE

- (1) Criteria for assessing the value of representative or unique wetlands.
- (2) General criteria for using plants or animals to identify wetlands of importance.
- (3) Specific criteria for using waterfowl to identify wetlands of importance.

Criterion 3 should read as follows:

A wetland should be considered internationally important if:

- a) it [regularly] supports 10 000 or more waterfowl; or

- b) it [regularly] supports substantial numbers of individuals from particular groups of waterfowl, indicative of wetland values, productivity, or diversity; or
- c) where data on populations are available, it [regularly] supports 1% of the individuals in a population of one species or subspecies of waterfowl.

3. Alteration of Criterion 2a following proposal 1 (page 4) of the NCC paper was judged sensible and accepted. Thus, Criterion 2a should be changed to read:

"A wetland should be considered internationally important if it supports an appreciable assemblage of rare, vulnerable, or endangered species or subspecies of plant or animal, or an appreciable number of individuals of any one or more of these species."

4. In the case of Criterion 2, the NCC proposal should be a starting point for development of guidelines within a worldwide context. It was judged that the proposals were relevant mainly to the European context (as intended) but not necessarily appropriate at the global scale.
5. The existing Cagliari Criterion 3 would benefit from detailed guidelines which should be designed in the immediate future to assist in the better understanding of the criterion. The NCC proposal 6 (page 8) seems highly appropriate with some rewording of the last paragraph using the IUCN Wetlands Office paper's paragraph 2a (page 3) (INF. C.3.9).

The third paragraph of NCC proposal 6 is to read:

"a particularly good representative of a type by virtue of being part of a complex of high-quality wetland habitats. A wetland of national value only could be considered of international importance if it has a substantial hydrological, biological, or ecological role in the functioning of an international river basin or coastal system."

6. It is recommended that a working group should tackle the development and coordination of further guidelines to the criteria with worldwide applicability.
7. It is recommended that the amended criteria should be reviewed by the Contracting Parties at the next Ordinary Meeting of the Conference.

CONVENTION ON WETLANDS OF
INTERNATIONAL IMPORTANCE ESPECIALLY AS
WATERFOWL HABITAT

Third Meeting of the Conference of the Contracting Parties
27 May to 5 June 1987
Regina, Saskatchewan, Canada

Agenda item XI: Workshop meetings

**Summary report of Workshop C:
Wise use of wetlands
28-29 May 1987**

The workshop was opened by Mr. V. Koester, Vice-Chairman of the Conference. Mr. M.Y. Alaoui (Morocco) was confirmed by consensus as Chairman of the workshop and Dr. P.J. Dugan (IUCN) as Rapporteur.

PROGRAM

Wise use of wetlands: consideration of the Biosphere reserve concept. M. Holland. (Distributed as INF. C.3.11.)

The implementation of the Wetlands Convention in the Netherlands. Netherlands delegation. (Read by D. Navid.) (Distributed as INF C.3.13.)

Notes on Provisions to Regulate Shooting in the Danish Ramsar Areas. P. Jepsen. (Distributed as INF. C.3.17.)

An integrated approach to the conservation and management of Kafue flats and Bangweulu basin: an example of managing wetlands for the benefit of people. H. Chabwela. (Distributed as INF. C.3.20.)

The wise use approach and the protection of Quintana Roo wetlands in Mexico. A. López Ornat. (Read by P. Dugan.)

International protection — Wadden Sea. K. van der Zwiep. (Distributed as INF. C.3.8.)

Position paper on wise use of wetlands in the USA. D. Pierce.

Proposición para el entrenamiento de gestores de zonas anegadizas en una planicie deltaica: Delta del Orinoco (Venezuela) (Proposal for training wetland managers in a delta plain: the Orinoco Delta, Venezuela). F. Pannier. (Distributed as INF. C.3.18.)

Wise use of wetlands in Guatemala. I. Ponciano.

Conservation and wise use of the Azraq oasis. M.Z. Abu Jafar.

Wise use of wetlands. G.E. Hollis. (Distributed as DOC. C.3.12.)

SUMMARY OF DISCUSSIONS

The final presentation by Dr. G.E. Hollis reviewed the introductory paper on wise use of wetlands prepared for the workshop by IUCN (DOC. C.3.12). This presentation provided the introduction to debate on wise use and consideration of recommendations to the Conference of Contracting Parties. Opening the discussion, two speakers, C. Ponce (Peru) and A. Diegues (Brazil), complimented Dr. Hollis on the recognition of the difference that exists between developed and developing countries in their wetland conservation goals. Diegues in addition emphasized that in order to use wetlands wisely in much of Brazil, the support of the local people had to be obtained. Unfortunately, many previous conservation efforts consisted of removing people from protected areas. Yet, in their absence, support for maintenance of the sites had decreased, and they had become increasingly vulnerable to development pressure.

The Swiss delegate (A. Antonietti) stressed that care should be taken in making a distinction between developed and developing countries. In particular, he noted that in the developed world detailed consideration of the socioeconomic importance of wetlands did need to be taken, and that a comprehensive strategy for wetlands conservation was equally as important here as in developing countries. He also noted that, when considering the development needs of developing countries, great care should be taken to distinguish between the real needs of these countries and the developed world's perception of these.

D. Blasco (IUCN) suggested that the definition presented in DOC. C.3.12 was too short to be clear for planners and other users. He therefore urged the workshop to clarify the definition.

I. Hepburn (RSPB) supported the concern expressed by the Swiss delegate that a distinction between the developed and developing world should not be stressed. He urged that an integrated approach to wetlands

conservation in the developed world was just as important as in the developing world. He also supported the comment of D. Blasco and suggested that guidance was required for achieving wise use. However, he agreed that the definition should be as succinct as possible.

The UK delegate (D. Langslow) also supported the view of the Swiss delegate. He felt that a clear distinction between the developed and less-developed countries was unhelpful and argued that wise use policies were needed as much in Europe and North America as in Africa. He suggested that the Ramsar Convention could draw Parties together so that they could work to conserve wetlands and integrate their efforts with the development process.

I. Ponciano (Guatemala) agreed that the precise interpretation of wise use would vary from country to country depending on conditions. He therefore suggested that while the definition was basically sound, it should make a reference to this variation between countries.

P. Havet (France) noted that the concept of wise use needed to recognize the distinction between reversible and irreversible changes to the wetland.

A. Diegues (Brazil) emphasized that while there were indeed major similarities in approach between developed and developing countries, Ramsar could only become of universal importance if it recognized the special goals of developing countries.

J. Correa (Mexico) noted the difference in dimension of the wetland areas in developed and developing countries. In Latin America, many wetland sites were so extensive that conservation and wise use implied elaboration of regional conservation and development plans which took account of the need to maintain the ecological and hydrological system.

L. Hoffman (WWF) agreed with the general consensus that there was no fundamental distinction between what was needed to achieve wetlands conservation in developed and developing countries. In his view, the difference lay in the ultimate goals. Thus, while the Ramsar Convention originally put emphasis on wildlife, and many people in the North still seemed to think this to be sufficient, he argued that Parties now needed to recognize that wetlands served much more important functions which provided a stronger case for their conservation. By emphasizing this, Ramsar could provide an important service to developing countries.

C. Noschese (Brazil) noted that in Brazil there was a mixture of high technology and traditional use of wetlands. There was therefore a need to integrate the two. Often environmental groups had argued for no use at all of certain sites, yet rather than aiding conservation this had proved to be an obstacle.

D. Figueroa (Venezuela) argued that on occasion no use of wetlands was the best use, for example in mangrove areas which supported important fisheries. Such areas needed to be identified and protected and distinguished clearly from others where sustainable uses could be pursued.

K. Ngwamotsoko (Botswana) argued that wetlands needed to be viewed as renewable natural resources. The definition should therefore include the concept of sustained utilization of renewable natural resources.

The Uruguayan delegate (R. Vaz-Ferreira) supported the view of L. Hoffman and emphasized that in his country water birds were of little concern in the decision-making

process. Other ways and arguments to conserve the wetlands needed to be found if wetland species were to be protected.

D. Pierce (USA) strongly supported the definition of wise use given in DOC. C.3.12, as it was succinct yet workable in all regions of the world.

T. Larsson (Sweden) urged that account be taken of the fact that water was a moving resource. In Sweden, a farmer could not carry out activities which would alter the water supply downstream. This should also happen internationally, and international agreements should be promoted by Ramsar.

RECOMMENDATIONS

Following the discussion of the papers presented, there was consensus that the workshop should make three recommendations to the Conference.

1. *Adoption of a modified definition of wise use.* While the definition presented in DOC. C.3.12 was seen to be succinct, it was felt to be too technical to be readily understandable to a broad audience. Accordingly, the workshop agreed that the definition should be revised to take account of this concern.
2. *Guidance on how to achieve wise use.* It was the feeling of the workshop that, while the ultimate goal of wise use might differ between countries of different socioeconomic conditions, there was no fundamental difference between countries in the way through which this could be achieved. The workshop therefore concluded that specific guidance on the steps through which wise use could be achieved should be provided to the Conference.
3. *Guidance on priority action to be promoted by the Parties.* While national wetland policies were the ultimate goal, it was felt that guidance should be provided on the immediate steps which Contracting Parties might now be taking to effect and promote wise use.

Given that the duration of the workshop had to be curtailed, participants appointed a Drafting Committee to formulate specific recommendations on these three points. This Committee consisted of the Chairman, Rapporteur, D. Figueroa (Venezuela), A. Diegues (Brazil), G.E. Hollis (IUCN), D. Langslow (UK), Y. Ntiemoa-Baidu (Ghana), P. Havet (France), and F. Pannier (Venezuela).

The Drafting Committee prepared three recommendations in line with the consensus of the workshop:

1. Wise use of wetlands can be defined as follows:

"THE WISE USE OF WETLANDS IS THEIR SUSTAINABLE UTILIZATION FOR THE BENEFIT OF HUMANKIND WHILE MAINTAINING THE NATURAL PROPERTIES OF THE ECOSYSTEM."

Sustainable utilization is defined as "human use of a wetland so that it may yield the greatest continuous benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations."

Natural properties of the ecosystem are defined as "those physical, biological, or chemical elements, such as soil, water, plant and animal species, and nutrients, and those functions which result from the operation of processes among and within these elements."

It is recommended that the above definition of wise use be considered for adoption by the Contracting Parties.

2. Wise use of wetlands requires action on an extensive scale, giving consideration to all factors affecting the wetland. This will imply establishment of national wetland policies. Major items in such policies should include:

- a national inventory of wetlands;
- identification of the benefit and values of these wetlands;
- definition of the priorities for each site in accordance with the socioeconomic conditions in each country;
- proper assessment of environmental impact before development projects are approved;
- ensuring that development projects affecting wetlands permit sustainable utilization;
- regulated utilization of wild fauna and flora, such that these elements of the wetland systems are not overexploited.

It is recommended that the Contracting Parties give particular attention to the wise use of wetlands by promoting elaboration of wetlands policies which contain these elements.

3. Recognizing that elaboration of national wetlands policies will be a long-term process, some immediate action can be taken to stimulate wise use of wetlands. These include:

- interchange of experience and information between countries seeking to elaborate national wetlands policies;
- training of appropriate staff in the disciplines which will assist in elaboration of such policies;
- pursuit of legislation and policies which will stimulate wetlands conservation action, and repeal of legislation which favours wetland loss;
- review of traditional techniques of sustainable wetland use, and elaboration of pilot projects which demonstrate wise use of representative national and regional wetland types.

It is recommended that these measures be adopted by Contracting Parties to the Convention.

CONVENTION ON WETLANDS OF
INTERNATIONAL IMPORTANCE ESPECIALLY AS
WATERFOWL HABITAT

Third Meeting of the Conference of the Contracting Parties
27 May to 5 June 1987
Regina, Saskatchewan, Canada

Agenda item XI: Workshop meetings

**Summary report of Workshop D:
The Ramsar Convention as a vehicle
for linking wetland conservation and
development**

29 May 1987

This workshop was opened by Mr. Abdul Latif Rao, one of the vice-chairmen of the Conference. Dr. Roberto Schlatter (Chile) was confirmed as Chairman of the workshop and Dr. Joost Van der Ven (IWRB) as Rapporteur. The Secretary General of the Conference gave a short introduction related to the workshop.

PROGRAM

Conservation and development in Botswana. K.T. Ngwamotsoko, Botswana. (Distributed as INF. C.3.22.) As an example, developments in the marshes of the Okavango Delta were presented.

Wetland conservation and development funding in Norway. S. Eldøy, Norway. (Distributed as INF. C.3.21.) An example of how one country organizes its development funding policy, incorporating the recommendation made by the UN World Commission on Environment and Development. The Ramsar Convention should reorient its present principles and incorporate the sustainable development concept.

Netherlands development funding in Northwest Africa. F. von der Assen, Netherlands. An example of financial help to North African conservation projects by the Ministry of Agriculture and Fisheries (also responsible for nature conservation).

Cooperation between Netherlands and Mauritania at the Banc d'Arguin National Park. I. Thiaw, Mauritania. A specific example of the principles presented.

International funding for past, present, and future conservation work at Garaet El Ichkeul, Tunisia. G.E. Hollis, IUCN. Overview of a project in which bilateral and international help led towards study, research, and training in a Ramsar site.

Statement to the multilateral and bilateral development assistance agencies concerning wetlands. S. Parcels, Natural Resources Defense Council. Short presentation regarding World Bank policy and wetland development.

The Ramsar Convention as a vehicle for linking wetlands conservation and development. Short introduction by P.J. Dugan, IUCN. (Distributed as DOC. C.3.13.)

SUMMARY OF DISCUSSIONS

Different opinions were presented regarding bilateral and multilateral funding. Advantages and disadvantages of both systems were mentioned. The Norwegian example was welcomed as a wise approach, and good results of such an approach were expected. The new approach by the World Bank was briefly mentioned, but no results could be given as yet.

It was recognized that multilateral and international funding took place through several international bodies (UNEP, for example). The fact that some of these bodies already existed should not impede the creation of others which could be more specific in scope (DOC. C.3.13).

It was noted that lack of coordination and the search for short-term financial gains could have a negative influence on results and cause unnecessary losses of wetlands and other important natural resources.

Inventories, research, and training should be carried out in the developing countries to ensure a better approach and a better use of natural resources. Funds should be made available for this, preferably as part of new projects or well in advance. The inventories of wetlands of international importance, promoted and carried out by WWF, IUCN, IWRB, and others in the Neotropics, Africa, and Asia were mentioned as good steps towards such an approach. It was hoped that these inventories would give guidelines for agencies involved in project financing in or near the areas mentioned in these inventories.

Once again, it was emphasized that research possibilities existed and were available through the world. Universities and specialized institutes could be approached, and the secretariat of the Ramsar Convention and other agencies could help to link the possibilities and the questions. Some support from the developing country concerned towards the needs of the researchers (e.g., local lodging, transport) would greatly help to speed up decisions on research questions. It was emphasized that local knowledge was often available and should be incorporated into this type of study.

Funding of projects would mainly take place through bilateral or multilateral contacts, and it was extremely important for these projects to take into account the value of the existing wetlands.

It was felt that the lack of influence from international nature conservation organizations and the Ramsar secretariat on development projects should be changed as soon as possible. It was not expected that a large part of the project money would go through the Convention, but the influence of the Convention and its secretariat could be enlarged to improve development projects.

Small-scale conservation projects, however, should not be forgotten, as they were also necessary towards certain developments. Self-funded projects and international assistance towards such projects were strongly endorsed.

On the national scale, it was felt extremely important that knowledge related to the ecological requirements of the area should be available to planners and decision makers. Much more attention should be given towards circulation and distribution of information with regard to these subjects. The secretariat of the Ramsar Convention, IUCN, and IWRB could be very helpful with distribution of this information.

It was felt to be a major disadvantage that, in developing countries in general, only ministries of finance or planning were involved in projects, and that ecological aspects were often forgotten. The need for a good ecological assessment should be emphasized by both donor and receiver. A national environmental institute or ministry would help to formulate ecological responsibilities.

It was emphasized that Environmental Impact Studies were not a luxury or a tool for making development aid difficult but were necessary to achieve better results for long-term projects and to link needs and circumstances with wishes and possibilities.

The Ramsar Convention was considered not as an instrument for funding but as an instrument to achieve better use of wetland resources on a long-term basis.

It was recommended that for the next meeting of the Conference of the Contracting Parties these subjects be studied. The question of whether changes to the text of the Convention were advisable or necessary to make its role more clear for Contracting Parties and others should be studied.

A small drafting committee drew up the report of Workshop D in which the Chairman, Rapporteur, Norway, Botswana, Environmental Database on Wetland Intervention (EDWIN), and Natural Resources Defense Council were represented.

CONCLUSIONS AND RECOMMENDATIONS

1. Countries will benefit by becoming Contracting Parties to the Ramsar Convention. Contracting Parties to this international treaty can expect help with their intention to make wise use of their wetlands. Developing countries should be informed of the benefits which can be derived from joining the Ramsar Convention. Benefits are varied and are not in monetary or financial terms only.
2. The Norwegian example was highly appreciated and endorsed. It is requested that this approach be circulated among the Contracting Parties.
3. The Ramsar secretariat can play an important role in linking knowledge and funds available to cover needs in the developing countries. It should take care that appropriate evaluation of projects should provide examples for the future.
4. The Ramsar secretariat should enlarge its influence in existing aid channels, so that projects financed through these channels take full account of ecological aspects, of special wetland conditions, and of the need for sustainable development.
5. A resolution, incorporating nine items arising from presentations in this workshop, is appended.

ANNEX

Resolution on a statement to the multilateral and bilateral development assistance agencies concerning wetlands

RECALLING the first four statements from the Preamble to the Ramsar Convention:

"RECOGNIZING the interdependence of man and his environment;

"CONSIDERING the fundamental ecological functions of wetlands as regulators of water regimes and as habitats supporting a characteristic flora and fauna, and especially waterfowl;

"CONVINCED that wetlands constitute a resource of great economic, cultural, scientific and recreational value, the loss of which would be irreparable;

"DESIRING to stem the progressive encroachment on and loss of wetlands now and in the future";

MINDFUL that over half of the world's wetlands have been lost since 1900, because the impacts of development upon wetlands have not been well understood, or because wetlands have been considered unimportant or even a hindrance to development or a "wasteland" that can be "reclaimed" for other uses;

CONVINCED that the mistakes of the past can be avoided in the future and that all Parties to the Convention can reap great economic and social benefits from integrated planning and the application of conservation principles in the development of their wetland resources;

NOTING that the multilateral and bilateral development assistance agencies play a significant role in the growth of nations' economies and social well-being;

COMMENDING these agencies for their efforts to help alleviate poverty and strengthen economies;

NOTING that, despite their important contribution to the economic and social well-being of a nation, these agencies have sometimes provided financial support for projects which result in unnecessary and short-sighted disruption or destruction of wetlands that provide important ecological and economic functions;

NOTING that the multilateral and bilateral development agencies are in a unique position to promote the wise use or conservation of wetlands to enhance the sustainable development of a nation,

THE THIRD MEETING OF THE CONFERENCE OF THE CONTRACTING PARTIES, meeting in Regina, Canada, from 27 May to 5 June 1987,

URGES the multilateral and bilateral development assistance agencies to give far greater attention to the biophysical and socioeconomic values that wetlands provide to people,

URGES that these efforts continue by giving higher priority to the conservation or sustainable use of wetlands,

URGES the bilateral and multilateral development assistance agencies to develop guidelines by project type that will ensure that the functions and values of wetlands are considered at all stages in the project cycle,

APPEALS to the Parties to the Convention and to the multilateral and bilateral development assistance agencies to note that, over the centuries, many societies have recognized the value of wetlands in their traditional lifestyle,

APPEALS to the Parties and the agencies to draw on this wisdom and realize in their policies and action the value of the ecological and hydrological processes which take place in wetlands and the socioeconomic importance of wetlands to people,

URGES the development assistance agencies to use their influence to promote through a two-way dialogue between donor and lender, and recipient and borrower nations, the following wetland conservation strategies:

- 1) to adopt national and regional wetland policies;
- 2) to protect critical wetland areas;
- 3) to initiate wetland inventories;
- 4) to promote wetland education and coordination programs;
- 5) to establish a land and water use assessment process;
- 6) to maximize productivity outside wetlands;
- 7) to acquire wetlands requiring total protection; and
- 8) to rehabilitate disrupted, nonproductive wetlands,

URGES development agencies and regional bodies such as the EEC to create a special wetlands program in order to coordinate and fund the integration and execution of coherent wetlands policies in all of their activities,

URGES the development agencies and regional bodies such as the EEC to withhold funds unless the project terms of reference provide for well-balanced decision making on the basis of an obligatory Environmental Impact Assessment, and

URGES development agencies and regional bodies such as the EEC to coordinate their programs at the international level to ensure that their independent activities do not in combination adversely affect wetlands.

The International Waterfowl and Wetlands Research Bureau.

IWRB was founded in 1954 as an independent non-governmental organization. It has an Executive Board, which comprises delegates from almost forty member countries and coordinators of seventeen Research Groups. The Bureau has its headquarters at Slimbridge, England. IWRB has a small staff which stimulates and coordinates waterfowl and wetland activities worldwide. By acting in this catalytic fashion, IWRB can achieve goals well beyond the means of its modest staff and financial resources. IWRB played an instrumental role in the creation of the Ramsar Convention, and now hosts a section of its secretariat, to which it provides technical support.

IWRB's Waterfowl Division coordinates the monitoring of waterfowl populations in over sixty countries through the International Waterfowl Census. The results of this and of studies coordinated through a number of Research Groups are used to formulate management plans for waterfowl populations and recovery plans for threatened species. IWRB's Wetland Division coordinates activities through a Wetland Management Group. Activities include the compilation of regional wetland inventories, analyses of the functions and values of wetlands, the preparation and implementation of management plans, publication of wetland management handbooks, organization of wetland workshops and training courses.

IWRB organizes numerous scientific symposia and publishes many reports and special publications. The *IWRB Bulletin*, published in January and July each year, carries information about these and other activities. For more information, write to: IWRB, SLIMBRIDGE, Gloucester GL2 7BX, UK.